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Tying: An Economic Analysis of the Google-Android Case

João Tadeu Fonseca de Andrade

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Supervised by
João Correia da Silva, PhD
António Manuel Cardoso Marques, PhD

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Abstract: Motivated by the recent antitrust investigations concerning the Google-Android case, this dissertation develops a theoretical model of bundling with compatibility costs based on the model of Cornière and Taylor (2018) adapted to Google's tying practices in smartphone pre-installed applications. Our model incorporates the specificities of the alleged efficiencies that Google claims to have when its applications are installed together and demonstrates the incompatibilities that rival's apps have when they are pre-installed. This dissertation aims to examine how the anticompetitive effects and the optimal decision of tying or pure bundling are affected by the introduction of synergies and compatibility costs. The results demonstrate that bundling produces the same anticompetitive effect regardless of the synergies that the monopolist has when its components are installed together, and the synergy does not rely solely on bundling in order to be realized. However, the synergy makes bundling a more optimal strategy, since the downstream firm bears the compatibility cost and rivals have more difficulties to install their components. Furthermore, we modified the sequence of negotiations and obtain the same results as in the original model: bundling continues to be strictly necessary to capture the global value of the tying component and reduces rival's willingness of paying slotting fees, regardless if its rival decide secondly its slotting fee. This dissertation attempts to provide additional insights on existing conflicts about EU competition policy action regarding tying practices and provide additional information on the determinants of the optimality of tying and its consequences to competition.

JEL codes: L1, L4.

Keywords: Tying, Bundling, Google, Competition Policy.

Resumo: Motivada pelas recentes investigações levadas a cabo pela Comissão Europeia sobre o caso Google-Android, esta dissertação desenvolve um modelo teórico baseado no modelo de Cornière e Taylor (2018) adaptado à prática de *tying* por parte da Google em aplicações pré-instaladas em dispositivos móveis. O nosso modelo incorpora as especificidades das eficiências que a Google afirma ter quando as suas aplicações são pré-instaladas em *bundle* e as incompatibilidades que seus concorrentes têm quando suas aplicações são pré-instaladas. Esta dissertação procura analisar como os efeitos anticompetitivos e a decisão ótima de *tying* ou "*bundling puro*" são afetados pela introdução de sinergias e custos de compatibilidade. Os resultados mostram que o *bundling* produz o mesmo efeito anticompetitivo independentemente das sinergias que o monopolista possa ter quando os seus componentes são instalados em *bundle*. Cumulativamente, a sinergia não depende apenas do *bundling* para ser realizada. No entanto, no nosso modelo esta prática apresenta-se como uma estratégia ainda mais ótima, pois o custo de compatibilidade é suportado pela empresa a jusante e a empresa rival apresenta maiores dificuldades em instalar o seu componente. Ademais, modificamos a sequência das negociações e obtivemos os mesmos resultados que o modelo original: o *bundling* continua a ser estritamente necessário para capturar o valor global do componente A e reduz o incentivo da empresa concorrente em oferecer *slotting fees*, independentemente de a última decidir em segundo lugar. Esperamos que nosso modelo providencie novas perspetivas sobre os possíveis métodos de análise por parte da política da concorrência em relação ao *tying* e forneça informações adicionais sobre os seus determinantes e consequências para a concorrência.

JEL codes: L1, L4.

Keywords: Tying, Bundling, Google, Competition Policy.

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AFA	Anti-Fragmentation Agreement
EC	European Commission
ECN	European Competition Network
GMS	Google Mobile Services
MADA	Mobile Application Distribution Agreement
NCA	National Competition Authorities
OEM	Original Equipment Manufacturer
OS	Operating System
RSA	Revenue Sharing Agreement
TEC	Treaty of the European Community
TFEU	Treaty on the Functioning of the European Union
WMP	Windows Media Player

1. Introduction

In July 2018, the European Commission fined Google with 4.34 billion euros for violating EU antitrust rules. According to the EC[1], "since 2011, Google has imposed illegal restrictions on Android device manufacturers and mobile network operators to cement its dominant position in general internet search." In other words, the firm was accused of abusing its market dominance on the Android operating system to perform illegal tying of applications such as Google Chrome and Search. Furthermore, the firm also abused its market dominance of the Search application and Google Play to impede the distribution of different operating systems based on Android open-source code.

In resemblance to other corporate strategies attractive to consumers, tying practices are increasingly more common, particularly in two-sided and digital markets (Holzweber, 2018). Antitrust efforts were mainly directed on the harms caused to consumers due to raising prices, but the majority of products offered by Google are free for the final consumer. Therefore, antitrust regulators have been hesitant to measure the real consequences and the intents of these practices[2].

Google services are increasingly present in our everyday lives. In a worldwide scale, 3 in 4 people with a handset device use the Android operating system[3]. According to Google's Economic Impact Report of 2018, Google Search and Advertising tools generated $335 billion U.S. dollars in economic activity in the U.S.A. Furthermore, in the most recently reported fiscal year, Google's revenue reached €122.1 billion and ranked first among worldwide internet companies, with a market capitalization of €457 billion[4]. Therefore, the study of anticompetitive effects from Google's tying practices reveals an issue of great economic relevance. Likewise to the Microsoft-Internet Explorer case, the resolution of the Google-Android case may set precedents to future competition policy measures regarding large technology firms which have significant role in our everyday lives.

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[1] European Commission - Press release "Antitrust: Commission fines Google €4.34 billion for illegal practices regarding Android mobile devices to strengthen dominance of Google's search engine" Released on 18 July 2018. Available at http://europa.eu/rapid/press-release_IP-18-4581_en.htm.

[2] Antitrust policy in multi-sided markets faces additional challenges because practices that are harmful to consumers in one-sided markets can benefit consumers in multi-sided markets, and vice-versa. See Correia-da-Silva, Jullien, Lefouili, and Pinho (2019) and the references therein.

[3] Mobile Operating System Market Share. Retrieved from: http://gs.statcounter.com/os-market-share/mobile/worldwide.

[4] Google's revenue worldwide from 2002 to 2018 (in billion U.S. dollars). Retrieved from: https://www.statista.com/statistics/266206/googles-annual-global-revenue/.

Although tying differs from the concept of bundling (Adams & Yellen, 1976), the term bundling is used in our model as a general term for "pure bundling", which represents the same economic concept and effects of tying (Holzweber, 2018; Kühn, Stillman, & Caffarra, 2005). Tying or "pure bundling" may be described as the act of selling a product or a service with a binding clause for the purchase of a different service or product (Tirole, 2005) in a way that the vendor threatens not to sell a good unless the another good is also sold (Carlton & Waldman, 2012).

The aim of this dissertation and its contribution to the literature consists in the modification of the baseline model of Cornière and Taylor (2018) in order to investigate, through the lens of Industrial Organization, how the optimal decision of tying is altered if synergies and compatibility costs are present and what are its anticompetitive effects in comparison to the original model. The inclusion of synergies and compatibility costs has the objective of approximating the baseline model to the specificities of Google's allegations[5] on the appeal of the Commission accusation. Additionally, a brief overview of the European Competition Law is provided in order to understand what are the infringements and the legal framework of Google's tying practices.

The model of Cornière and Taylor (2018) presents a multiproduct upstream bundling structured as the following: A downstream company (D) sells a finished good made from components obtained from upstream suppliers to final consumers at price p. The components are divided into two categories, A and B. For component A, firm U_1 is the sole producer. For component B, U_1 and U_2 firms compete to sell their own type (B_1 and B_2, respectively). Firm D can only install one version of component B.

In addition to the extension of the Cornière and Taylor (2018) model, I also modify the sequence of the negotiations in order to verify if the same results hold. Specifically, if bundling continues to be strictly necessary in order to capture the global value of component A, if it reduces rival's willingness of paying slotting fees and lastly, how the feature of the upstream rival firm deciding secondly affects the optimal decision of bunding.

The results reveal that bundling produces the same anticompetitive effect regardless the synergies that firm U_1 has when its components are installed together, and the synergy does

[5] See "Android has created more choice, not less". Published Jul 18, 2018. Available at https://blog.google/around-the-globe/google-europe/android-has-created-more-choice-not-less/.

not rely solely on bundling in order to be realized. Moreover, bundling is even a more optimal strategy in our model, since the downstream firm bears the compatibility cost and U_2 has increased difficulties to outbid U_1's slotting fee. Regarding the timing modification, the results obtained are the same as the original model: bundling continues to be strictly necessary to capture the increase of slotting-fees and sales, caused by component A installation and reduces rival's willingness of paying slotting fees, independently from if U_2 decide secondly its slotting fee.

The dissertation has the following structure: The first Chapter is dedicated to the introduction. In Chapter 2, the general framework of the European Competition Law and its approach to tying practices are explained. Chapter 3 proceeds to the literature review of tying. It presents the seminal work in the field and identifies its motives, methods and effects. Thereby providing the foundations of the dissertation. In Chapter 4, the pertinent features of Google-Android case are presented and substantiated by different points of view from the recent related literature. Chapter 5 presents the modified sequence of the negotiations from the baseline model of Cornière and Taylor (2018). Then, it proceeds to the model with compatibility costs coupled with the results of such modification. In Chapter 6, the results are discussed and compared to the original model and other models from the literature of tying. In the last Chapter, the main conclusions and limitations of our research are presented.

2. EU Competition Law

The European Competition Law regulates and prevents any anticompetitive conduct by undertakings[6] to ensure the maintenance of competition within the European Single Market. Specifically, it prevents the occurrence of any anticompetitive agreements such as: abuse of dominant market position, cartels, invalid mergers and acquisitions, or biased State intervention (Chappatte & Boyce, 2018). According to the Directorate General for Competition, competition enhances innovation and efficiency. As consequence, goods and services are offered at the most favourable terms for consumers. Nonetheless, in order to be effective, competition requires independent firm's decision-making coupled with competitive intention.

Currently, the European antitrust law is based on the Articles 101 to Article 109 of the TFEU and some European Directives and Regulations. However, its backbone consists of two central rules set out in the Treaty on the Functioning of the European Union, the Articles 101 and 102. The first article averts any anticompetitive practice that could disrupt free competition and Article 102 prevents any abuse of dominant market position (European Commission, 2012). Therefore, Article 102 presents as the second key provision after Article 101. Lastly, the European Commission has adopted various non-regulatory documents such as guidelines, notices, handbooks, et cetera. which have the purpose to explain more deeply the actions of the Commission on procedural issues or antitrust rules' interpretations.

The Treaty has the force of law over the European Economic Area (EEA) to secure the Single Internal Market and ensure the free movement of goods and services throughout the European Union. Generally, the TFEU is imposed by the European Commission but, in certain circumstances, it can be imposed by the Member States' National Competition Authorities (NCAs). The two entities enforce together the EU antitrust rules in the framework of the European Competition Network (ECN). Since 2004, the Commission and NCAs have investigated a wide range of cases and adopted over one thousand decisions. Since then until 2014, over 85% of antitrust rules' decisions were applied by NCAs.[7] The National Competition Authorities are fully empowered to apply Articles 101 and 102 of the

[6] In EU antitrust law, an undertaking is any entity with an economic activity regardless of its legal status and the form in which it is financed. No intention of profits is required, nor are public entities excluded (European Commission, 2005).

[7] European Commission - Press release "Antitrust: Commission proposal to make national competition authorities even more effective enforcers for the benefit of jobs and growth". Released on 22 March 2017. Available at: http://europa.eu/rapid/press-release_IP-17-685_en.htm.

Treaty and may also apply provisions to protect the individual rights conferred to European citizens by the Treaty.

The Commission's investigative authority to enforce Articles 101 and 102 is described in the Antitrust Regulation 1/2003[8]. The Commission has also the capability to impose fines aimed at "punishment and deterrence". The fines regard the duration and gravity of the infringement and are calculated under the framework of EC's guidelines[9]. The respective undertakings have the right to appeal to the EU General Court, in order to annul or emend the Commission's decision. Subsequently, the General Court can reduce, increase or cancel the fine imposed by the European Commission.

2.1. Article 101 TFEU (ex-Article 81 TEC)

Article 101 forbids any agreement between two or more independent undertakings which restrict or distort competition and transactions between Member States. This provision has the purpose of preventing any anticompetitive practice involving agreements between actual or potential competitors operating at the same level of the supply chain (horizontal agreements) and agreements between undertakings which operate at a different level of the production or distribution chain (vertical agreements) (European Commission, 2013a). This article applies to oral agreements, non-binding arrangements and understandings, express written contracts and other types of informal collusion.

The focus of the Article 101 relies on the undertaking's anticompetitive practices such as: directly or indirectly price-fixing; limit or control of the markets, investments, technical development or production; implementation of contracts with unequal conditions to equivalent transactions and contracts, which detriments competition; market or source of supply cartels; supplementary obligations with no connection with the subject of the contract. A noteworthy example of the infringement of Article 81 TEC was the €74 million fine on Sony, Fuji and Maxell in 2007 for fixing prices for professional videotapes sold to customers in Europe.[10]

[8] See "Antitrust Regulations". Available at: http://ec.europa.eu/competition/antitrust/legislation/regulations.html.
[9] See "Guidelines on the method of setting fines imposed pursuant to Article 23(2)(a) of Regulation No 1/2003". Available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52006XC0901(01)
[10] For further information about the case, see "Antitrust: Commission fines professional videotape producers over €74 million for price fixing cartel". Available at: europa.eu/rapid/press-release_IP-07-1725_en.pdf.

The Commission applies Article 101 on concerted practices which have no effects on the market but reveal anticompetitive intention. And the same applies when the agreement or practice has no anticompetitive intention but causes anticompetitive effects. Still, the effect must be substantial. Article 101(2) considers any undertaking found in breach of Article 101 TFEU to be null and void. Therefore, the previous agreements cannot be legally enforced.

2.1.1. Exemptions to Article 101 TFEU (Article 101 (3))

The third paragraph of Article 101 empowers the Commission to make some narrow exceptions applied to individual agreements. It provides a degree of flexibility in vertical agreements or other concerted practices if the beneficial effects outweigh the anticompetitive impact.

An agreement or practice is exempt from Article 101(1) if it contributes to the following four cumulative conditions: improves production and distribution of goods, or technical or economic progress, allows consumers a fair share of the resulting benefit, and cannot:

- Article 101(3a) – "Impose any restrictions which are not indispensable to the attainment of those objectives."
- Article 101(3b) – "Give the undertakings concerned the possibility of eliminating competition for a substantial part of the products in question."

Additionally, the exemption can also be applied through block exemption regulations which are divided into three main categories[11] (vertical agreements, horizontal cooperation agreements, and licensing agreements for technology transfer). The first, since certain contracts can improve economic efficiency within a chain of production or distribution by facilitating better coordination between the undertakings, the Commission established a group of block exemptions with the acceptable and prohibited contract terms (*hardcore restrictions*) for diverse types of vertical agreements[12].

[11] See Exempted agreements Article 101(3) TFEU. Available at: http://ec.europa.eu/competition/antitrust/legislation/art101_3_en.html.
[12] See Commission Regulation (EU) No 330/2010 of 20 April 2010 on the application of Article 101(3) of the TFEU to categories of vertical agreements and concerted practices.

As the second category, the European Commission exempts "Agreements of minor importance"[13] from Article 101(1) (except agreements with fixing sale prices). This exemption is applied to companies which together represent less than 10% of the pertinent market in the case of horizontal arrangements, and 15% each in case of vertical agreements. This exemption is known as the "*De minimis notice*".

As the last and third block exemption, the Article 101(3) allows anticompetitive practices if they are beneficial to consumers, by facilitating technological efficiencies or lower prices without restricting all competition in the concerned industry.

Only a small number of official exemptions were given by the European Commission. A real-world example of an implemented exemption of the Article was the CEPSA case[14], where the Commission's Guidelines on Vertical Restraints recognized that "resale price maintenance" could benefit consumers, prevent free-riding and encourage new entry.[15]

2.2. Article 102 TFEU (ex-Article 82 TEC)

Article 102 of the Treaty on the Functioning of the European Union (formerly Article 82 of the TEC) has the objective of preventing undertakings who hold a leading position in a given market from abusing its position of dominance. Few companies hold the sufficient market power to be investigated under Article 102. Nevertheless, a company could enjoy a significant market power and have low dominance in a specific geographic market or product market. The boundaries of geographic and product markets may be blur in certain cases, but the EC must define them precisely to assess dominance.

According to the European Commission (2005), a dominant position can be described as a circumstance where the economic power held by a company could endanger the maintenance of its competitors, customers and consumers. Moreover, the Commission states that an undertaking with high market share and for a long period of time is more likely to be a preliminary indication of dominance. Generally, a company is unlikely to be dominant if it has a market share of less than 40%. Although, some companies can become under scrutiny even if they have low market power. Having a dominant position in the market is not itself

[13] European Commission, Notice on Agreements of Minor Importance which do not Appreciably Restrict Competition under Article 101(1) TFEU, OJ C 368, 22.12.2001, p.13-15.
[14] Case C-279/06 CEPSA Estaciones de Servicio SA [2008] ECR I-6681.
[15] European Commission, Guidelines on Vertical Restraints, 2010/C.

a violation of the EU competition law but dominant undertakings have a special responsibility to behave in a way that does not harm competition.

Objectively, the Article prohibits the following practices by dominant undertakings: Predatory Pricing (pricing at unfairly low levels with evidence of intention to exclude a competitor); Excessive Pricing (non-justifiable high level of price in order to difficult relevant transactions); Fidelity Rebates (discounts with the intention to exclude more inefficient competitors from the market); Refusal to Supply (refusal to sell to a certain customer); Tying (contracts subject to complementary purchase obligations); Discrimination (dissimilar transaction terms that may be considered abusing with no objective reason).

Some notable examples of Article 102's infringements include Google's abuse of its market dominance in search engine by giving an illegal advantage to its shopping comparison service, resulting in a fine of €2.42 billion [Decision 2019/417]. The €1.06 billion fine imposed on Intel in 2009 for engaging in illegal exclusionary practices on the market for a x86 central processing units (CPUs). Lastly, the case of Deutsche Post AG concerning the market for business parcel services for attempting to eliminate competition by predatory pricing [Decision 2001/354].

2.3. European Commission on Tying

In the assessment of tying practices as possible abuse, the European Directorate General for Competition verifies if the contracts and its effects correspond to Article 102(d). Although, since the practice includes an agreement between undertakings, tying and bundling also fall within the ambit of Article 101(e) (Holzweber, 2018). Conferring to both Articles, it is considered abusive "the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts". Henceforward, the Commission considers that anticompetitive tying occurs when the subsequent four elements are present[16]: **(i)** the tying and the tied goods are distinct products; **(ii)** the firm is dominant in the tying market; **(iii)** the tying practice is not justified objectively nor produce efficiencies; **(iv)** the tying practice is likely to have a market distorting foreclosure effect.

[16] Commission Decision, 53/07, 2007 O.J. (L 32) 23, 26 (EC).

(i) Fundamentally, two products are considered distinct if the demand indicates it. If the demand for one product decreases when the other is increased and vice-versa, it reveals substitutability between goods. Thus, when the demand for both products is dependent on each other, it reveals strong evidence of products belonging to the same market (Holzweber, 2018). However, in order to foreclosure, tying must involve two different markets. If the two products belong to the same market, the only possible anticompetitive practice is predatory pricing or rebates (Holzweber, 2018). An indirect evidence of belonging to different markets is when, in competitive markets, firms with reduced market power tend not to bundle the products, because attends better customer's demand by selling them separately (European Commission, 2005)..

(ii) This aspect does not necessarily imply that the company is also dominant in the tied market. Nevertheless, as established in Article 102, if the firm is dominant in both markets for an extended period of time, the ground of abuse of market dominance is more probable.

(iii) Tying may be considered abusive when the sale of separate products could be obtained with same or better conditions than the bundle. In other words, if the restrictions imposed by the tying practice are dispensable for the achievement of the objective (Article 101(3a)).

Although, according to Article 101(3) this could be justified and tolerated if generate efficiencies in production, distribution or transaction. In some cases, contractual tying might be even necessary to achieve efficiencies when they are not apparent. This is a common feature of products that are technically integrated in a way that is difficult for supplying one without supplying another (e.g. cars with tires or shoes with shoelaces), but in such cases, the combination of two or more separated products should be considered as one product. Additionally, it is not a dominant firm's responsibility to decide which products are inferior or not through contractual tying. And, if the practice excludes a significant part of the competition, all the benefits and efficiencies arising from practice are disregarded (Article 101(3b)).

(iv) The more common anticompetitive effect of tying is foreclosure of the tied market and, in a general way, the EC assessment of foreclosure consists of two parts (European Commission, 2011): **a)** determine which customers are "tied"

(*id est,* which rival's costumers are lost to the dominant company); **b)** and specify whether these "tied" customers constitute a relevant market share.

The identity of the tied customers reveals to be central in the assessment of the foreclosure effect (Graf, 2004). The tie could have a specific foreclosure effect if the tied customers are specifically important from an entry-deterring point of view (European Commission, 2005). Fundamentally, the foreclosure effect is as higher as the dimension of the "tied sales" on the tied market and it is also greater in the presence of significant network effects, learning curve or scale economies in the second market (Tirole, 2005). However, with product differentiation, the foreclosure effect may be reduced, since rival firms are more likely to remain in the market due to the customer's loyalty and preferences (European Commission, 2005).

Two of the most distinguished decisions from the European Commission concerning to tying practices was in 2004, when Microsoft infringed the Article 102 of the TFEU by tying Windows OS with Windows Media Player.[17] And in 2008, when it bundled its operating system with its internet browser. The Commission argued that Microsoft leveraged its dominant position on the PC operating system market for anticompetitive motives either on the WMP and Internet Explorer programs. Another example was the Tetra Pak II in 1991 case where the company tied the sales of Tetra Pak equipment to use Tetra Pak cartons on Tetra Pak machines[18].

[17] Commission Decision, 24 March 2004, Case COMP/C-3/37.792 Microsoft.
[18] Tetra Pak International SA v Commission [1996] ECR I-5951. Case T-83/91 [1994] ECLI:EU:T:1994:246.

3. Literature on tying

In this chapter, the literature review on the concept of tying is provided. The literature on the subject offers vast and different economic explanations, which could be complementary to each other. In a general way, firm's motivation for tying two or more products may come from one of the following reasons: **i)** leveraging its market dominance into the tied market; **ii)** achieving better price discrimination; **iii)** realize efficiencies or complementarity between components; **iv)** deterring entry.

However, due to the wide-ranging assumptions and market structures that different authors use on their models, the motivations for tying may differ slightly from the ones previously mentioned. In the following subsections, it is addressed these diverse characteristics, currents of thought, forms of implementation and effects on competition, innovation and consumers.

3.1. Definition of tying

Tying, or pure bundling, may be described by the act of selling a product or a service with a binding clause for the purchase of a different service or product in a way that the vendor threatens not to sell a good (tying good) unless another good (tied good) is also sold (Tirole, 2005). The best candidate for a tied good is frequently a complementary product (Amelio & Jullien, 2012; Nalebuff, 2004).

Citing Whinston (1990, p. 839), this practice "provides a mechanism whereby a firm with monopoly power in one market can use the leverage provided to foreclose sales and monopolize a second market". As result, it alters the price equilibrium, shift profits from the tied good to the monopolist of the tying good (Carlton, Gans, & Waldman, 2010) and make the tying product more valuable (Amelio & Jullien, 2012; Gans, 2011). Furthermore, tying also circumvents the non-negative price constraint in the tied product, and according to Carbajo, Demeza, and Seidmann (1990), segment the market and relaxes price competition.

Since the sale of one product increases the sales of another unrelated product, thereby asphyxiating competition in the second market, tying constitutes as an anticompetitive practice. Whinston (1990) describes it as "strategic foreclosure". In addition, such practice blocks entry of potential competitors which cannot reach minimum viable scale economies (Carlton & Waldman, 2002; Ide & Montero, 2016; Whinston, 1990) and, if credible,

discourages investment and innovation (J. P. Choi & Stefanadis, 2001). As result, harming the competition in the tied market in the long run.

It is important to emphasize that the tying concept differs from the concept of bundling, which is a common and legal method of price discrimination. Bundling is the joint act of selling two or more goods, at a discount or as complement in order to guarantee a continuous flow of sales of the complementary good (Adams & Yellen, 1976). In the practice of bundling, the two goods in question are related or complementary[19] and there is the option of buying separately (mixed bundling). Tying (pure bundling) means that the products are available only as a bundle (Tirole, 2005). The distinction between tying and pure bundling is inconsequential if the tied product is valueless without the tying good (Tirole, 2005). The term pure bundling is more often used in economic literature and the term tying is more frequent in the antitrust literature (Kühn et al., 2005). Therefore, when the terms bundle and tying are used in this dissertation, both refer to the concept of pure bundling.

3.2. The "Chicago School" argument

Concerning the leverage theory of tying, the "Chicago School of Economics" (Bowers, 1980; Bowman, 1957; Director & Levi, 1956; Posner, 1976) with neoclassical price theory, proclaimed that a monopolist firm cannot transfer its market power to another market and become "double" monopolist. This principle is known as the "one monopoly profit theorem" (Carlton & Waldman, 2014). The "Chicago School" explained that when the monopolist bundle two products and they are complementary to each other, there is only one final product. Thus, only one monopoly profit to be exploited. Furthermore, the authors claim that makes no economic sense to enter into the tied market if the last is perfectly competitive (i.e. prices are equal to the marginal cost), because customers will only buy the bundle if the increase of the tied product price equals to the valorisation of the tying product by consumers (Holzweber, 2018). Although, in such pricing, the consumers who buy the bundle are the same who buy the tying good alone, thus there is no profit increase (Nalebuff, 2004).

The Chicago School state that tying practices exists with the objective of achieving better price discrimination, protecting goodwill, achieving economies of scale, risk-sharing and

[19] Although, the concept of product distinction is vague and calls up some complex issues. In legal cases, two products are deemed unrelated if, in the absence of tying or bundling, consumers would purchase the products separately (Tirole, 2005).

evade price regulation (R. Bork, 1978). Therefore tying is never anticompetitive and should not be considered as an antitrust violation, because none of these motivations harm competition (R. Bork, 1978). Although, since the Chicago School's arguments are founded on a number of highly restrictive theoretical assumptions (for instance, perfectly competitive markets with perfectly informed consumers) the recent economic literature, such as Whinston (1990), J. P. Choi and Stefanadis (2001), Carlton and Waldman (2002) and Farrell and Katz (2000) resurged the legitimacy of the "leverage theory". Furthermore, the Chicago School's laissez-faire approach and its assumptions on tying is less applicable in the digital markets (Gans, 2011; Holzweber, 2018). In the latter markets, marginal revenue is considerably higher than (null) marginal costs and most digital goods are non-rivalrous and have network-effects (Holzweber, 2018).

3.3. Forms of tying

The most common form of tying is through contractual methods. However, vendors could also use technical or technological arrangements by making the tied and tying product integrated in a way that they become physically impossible to separate (J. P. Choi & Stefanadis, 2001; Geradin & Edelman, 2016; Gilbert & Riordan, 2007; Whinston, 1990). There are some real-world examples of technical bundling: cars with motors and seats, shoes are sold in pairs, etc. An obvious reason is that firms can integrate their products better than their customers. However, such simple examples are not relevant to competition policy. In fact, the focus of antitrust regulators is technical arrangements which have the purpose of producing anticompetitive or entry-deterring effects. For example, the IBM case[20], where IBM required its consumers to buy its punch cards for its tabulating machines in order to function correctly.

The use of contractual tying, similarly to Google's contracts with smartphone manufacturers, can increase the credibility of tying (Carbajo et al., 1990). The literature differentiates contractual tying from technical tying, as the first can be untied afterward with a moderately low cost while the latter only with a substantial cost. Hence, technical tying could be used to pre-commit to tying when contractual tying is not credible (Whinston, 1990). Carlton and Waldman (2002) consider another possibility of tying, a virtual tying

[20] International Business Machines Corporation v. United States (298 U.S. 131 [1936]).

through pricing, where the monopolist set a high price for the primary product and a near zero price for the complementary good. Although, it is a low credible strategy.

Regarding the credibility of tying, Nalebuff (2004) states that tying is credible without needing any commitment because even if it fails to deter rival's entry, the monopoly profit loss is mitigated. Thus, tying is an optimal option in both scenarios.

3.4. Incentives and Effects

The majority of the literature on tying is based on either price discrimination[21], market foreclosure or efficiency rationales (Carlton et al., 2010; Dana & Spier, 2015; Nalebuff, 2004). Carlton et al. (2010) identify as the first potential driver for tying, the incapability for a monopoly to charge a small price for a good when it must firstly supply its indispensable complement. And, as the second, when consumers of the complementary product face compatibility costs. For example, Windows Media Player is already embedded in Windows operative system, this eliminates compatibility and installation costs for consumers. Without tying, consumers decrease their value for the product because those costs are carried by them (Amelio & Jullien, 2012; Carlton et al., 2010; Gans, 2011).

Amelio and Jullien (2012) corroborate this argument in the two-sided markets, describing that tying could boost efficiency by improving coordination between related products, create more demand in the tied product and as consequence, increasing its membership value. Nonetheless, for both authors tying strategies does not necessarily involve the reason of leveraging market power from another market, it could be merely the transfer of profits from the complementary good market to the monopolist without eliminating competition, like the price discrimination purpose of tying (Chen & Riordan, 2013). Furthermore, Carlton et al. (2010) refute that tying hurts consumers in presence of price discrimination or exclusion effects. In fact, according to Nalebuff (2004) tying is even more profitable for the monopolist when it has an entry-deterrence effect.

Kühn et al. (2005) declares that tying has undoubtedly anticompetitive effects and the real debate is recognizing the conditions under which anticompetitive effects occur and what criteria should be selected to validate untying. Gayer and Shy (2016) also affirm that tying decreases consumer surplus and total welfare in comparison to a scenario of absence of tying

[21] For more literature on price discrimination argument of tying. See, for example, Adams and Yellen (1976), Schmalensee (1982), McAfee, McMillan, and Whinston (1989), Salinger (1995), Matutes and Regibeau (1992), Bakos and Brynjolfsson (1999) and Greenlee, Reitman, and Sibley (2008).

under high production costs. Although, under low production costs the opposite results occur. This is shown by the Microsoft bundling of Microsoft Office (Excel, Word, PowerPoint and Exchange), where it has zero marginal costs and the bundle create synergies between the products for consumers. And, as the marginal costs rise, the incentive to bundling diminishes (Nalebuff, 2004).

The practice of tying can be also sub-sectioned in two: reversible and irreversible tying. Carlton et al. (2010), designates the first as the consumer's ability to purchase a tied good and another rival complementary good simultaneously. The irreversible does not allow the simultaneously. In costless reversible tying, establishing a null price for the complementary good has no incremental return, like Microsoft's strategy on Windows's and Windows Media Player. Nonetheless, the motivation for a monopolist to tying, according to Carlton et al. (2010) is substantial even without competition. In the presence of rival producers, reversible tying is often inefficient since consumers could use the monopolist's rival complementary good even after purchasing the monopolist's tied product.

Whinston (1990) states that with competition in the complementary good market, tying an essential primary good provides no monopoly returns. The term essential means that all applications of the complementary good necessitate the monopolised product, such as Microsoft's Windows and Windows Media Player or IBM's tabulating machines and tabulating cards. However, Whinston (1990) considered assumptions such as irreversible tying and, in the absenteeism of competition, the monopolist has no incentive to bundle. Carlton et al. (2010) refer that the monopolist's costs of producing and developing the complementary good signify a deadweight loss if consumers are indifferent between the tied product and its rivals, similarly to Microsoft's behaviour in tying complementary software, such as movie editing, security programs and instant messaging. Nonetheless, refuting Whinston (1990), Gans (2011) declares that in a market for an essential product like operating systems, the gain on competition for applications, allows the monopolist to increase revenue in the monopoly market. This setting occurs in the Google abuse of market power in complementary products. The firm use Android to reinforce its market position on Google Search engine (Geradin & Edelman, 2016).

Recently, several authors begin to include different assumptions into their models in order to describe the subtleties of the digital and technological markets. For example, Carlton and Waldman (2012) stress the relevance of switching costs and product upgrades on tying.

If product upgrades are vital for the complementary product this generates incentives for tying. These incentives increase if the complementary good is characterised by switching costs. Therefore, a monopolist increases its profits by tying and leveraging if the tying product is essential. This is related with several of Microsoft's bundled programs such as, Internet Explorer and Windows Media Player (Carlton et al. 2012).

More recently, after Whinston (2001), J. Choi and Jeon (2018) highlight the presence of network effects in tying practices. According to the latter authors, in models of anticompetitive tying and exclusionary contracts in two-sided markets, tying deprives rival's sales and weaken its future competitiveness. Furthermore, Amelio and Jullien (2012) state that if network externalities are numerous and competition intense, total welfare increases. For instance, in the software industry, the developers of applications write their software towards the more widely used operating system. Subsequently, users choose the operating system which contains the greatest variety of applications. And as result, it becomes more probable for an operative system to become monopolist. This is known as the "applications network effect" (Kühn et al., 2005).

After analysing several different points of view about tying, an important question arises: Could tying present potential benefits? The practice seems to benefit consumers when they are faced with compatibility and distributing costs (Kühn et al., 2005), accountability if a product malfunctions and protection of intellectual property (Carlton & Waldman, 2012). The software industry is a perfect example of the positive effects of tying. Though, the practice has unclear effects when employ price discrimination (Tirole, 2005). The benefits for producers resulting from tying efficiencies derive from economies of scope and efficiency of vertical structures (Jeon & Menicucci, 2012). Still, this is not an acceptable justification for tying, even in software industry, because the benefits from economies of scope do not rely solely on the presence of technical or contractual tying (Kühn et al., 2005). The European Commission is very keen on this last aspect. According to Article 101(3a) of TFEU, tying or bundling can even produce efficiencies and benefits consumers, but they should not be permitted if the same effects are achieved without these two practices.

3.5. Proposed remedies

In summary, Tirole (2005) suggests that antitrust tying case's analysis can be breakdown to a three-step procedure: **(i)** Recognizing if the practices reduce competition in the tied market; **(ii)** identifying if tying hurts consumers; and **(iii)** if exists an appropriate remedy.

Under Article 102 of the EC treaty, Tirole (2005) observed the link between this three-step approach and the standard treatment of tying cases. Reclassifying tying as predatory strategy (whether it aims at monopolizing the market or protecting it) clarifies the economic analysis. Still, it has some limitations. Antitrust authorities may not know if tying has an efficiency rationale or purely predatory intention (Tirole, 2005). Conferring to Carlton et al. (2010) there are monopolist bundles which have no effect on competition's entry and exit decisions. However, such practice increase monopoly profit and lower rival profits and social welfare. Hence, a difficult scenario occurs when the incriminated behaviour has, simultaneously, efficiency and anticompetitive rationales. Tirole (2005) states that firms can't be inefficient and not improving their productivity to simply maintain their competitor's existence. In order to measure the welfare, economists often add these two variables but antitrust authorities, more specifically the Article 101(3) TFEU, focus more on how the practice affects consumer surplus.

Mandatory untying could be a good antitrust policy because increases consumer's choice and, if pre-installation has costs, which would not be incurred in absent of tying, this measure also increases social welfare and competition (Gans, 2011). Carlton and Waldman (2002) also corroborate this thesis, stating that mandatory untying increases welfare and could be the most effective policy action. Although Kühn et al. (2005) agree with mandatory untying, the difficulty is to identify the anticompetitive effects. For instance, in industries where network effects are central, such as the software industry, antitrust regulator's intervention could harm future innovation and competitiveness. In such industries, anticompetitive effects are likely to exist if there are network-based mechanisms which decreases rival's investment and R&D. Generally, these aspects display hints of intent to exclude and reveals absence of efficiency motivations. Therefore, there is a strong case for antitrust intervention (Kühn et al., 2005).

4. Google Android Case

The European Commission declared that Google's conduct on its smartphone's services and applications has violated EU antitrust rules, more specifically the Article 102.[22] The process can be divided into three forms of contractual restrictions enforced by the company on network operators and original equipment manufacturers (OEMs). The Mobile Application Distribution Agreement (MADA), Revenue Sharing Agreement (RSA) and Anti-Fragmentation Agreement (AFA). All three have the objective of increasing of Google Search traffic through Android Operating System's users (Etro & Caffarra, 2017; Geradin & Edelman, 2016)[23]. Nevertheless, Cornière and Taylor (2018) claim that the predation case is doubtful because Google's strategies have been present for some years and credible rivals still exist on the search engine and browser markets. For example, Bing and Microsoft Edge, respectively.

As the first type of restriction, the firm leverages its dominance on the market of app stores, Google Play app, in order to protect and expand its market power on Google Chrome and Search. This practice prevents the entry of new competitors and harms the existing ones (J. Choi & Jeon, 2018; Cornière & Taylor, 2018; Edelman, 2015; Etro & Caffarra, 2017). According to MADA[24], if an OEM chooses Android as its Operating System and intents to pre-install the Google Play application, the OEM is required to install other applications belonging to the Google Mobile Services (for example, Google Search, Maps, Chrome) even if the manufacturer prefers to pay for another competing app (e.g. Bing Search, DuckDuckGo, MapQuest or Yahoo Maps)[25].

Rendering to Geradin and Edelman (2016) the Google Play application reveals to be crucial, because not having Google Play installed on the handset device constitutes a manufacturer's weakness, since the absence of the app results in some incompatibilities with

[22] European Commission - Press release "Antitrust: Commission sends Statement of Objections to Google on Android operating system and applications" released on April 20, 2016. Available at http://europa.eu/rapid/press-release_IP-16-1492_en.htm.
[23] European Commission - Fact Sheet "Antitrust: Commission opens formal investigation against Google in relation to Android mobile operating system," released on April 15, 2015. Available at http://europa.eu/rapid/press-release_MEMO-15-4782_en.htm.
[24] Although MADA is confidential, it was available during the Oracle v. Google litigation and provide a general understanding of the conditions under which Google licenses its proprietary mobile apps.
[25] Devices may only be distributed if all Google Applications [listed elsewhere in the agreement] ... are pre-installed on the Device." See section 2.1 of the MADA between Google and HTC.

other Google apps and its installation ensures that applications using Google APIs[26] have proper communication with other Google online services (Etro & Caffarra, 2017).

The MADA does not prevent OEMs from pre-installing other rival's apps. Still, Google requires its apps to be the default apps and displayed on prominent positions on the screen.[27] But two problems arise, pre-installing equal applications is constrained by the limited screen space available on mobile devices and limited prominent positions the screen (J. P. Choi, Jullien, & Lefouili, 2017; Etro & Caffarra, 2017). Furthermore, as known in the literature of tying and similarly to Internet Explorer case, this "default bias" was one of main decisional features for the EC to proceed with the accusation (Etro & Caffarra, 2017). Second to the European Commission's investigation in 2016, 95% of search queries were made using Google Search on devices that had it pre-installed. Meanwhile, on Windows Mobile devices, where Google Search and Chrome are not pre-installed, less than 25% of all search queries were made via Google Search. The European Commission specifies that "consumers rarely download applications that would provide the same functionality as an app that is already pre-installed (unless the pre-installed app is of particularly poor quality)."[28] The "default bias" is then confirmed in this circumstance.

As the second part of the case, some selected mobile network communications and smartphone manufacturers received anticompetitive financial incentives to pre-install Chrome and Search in detriment of rival applications[29]. These allegations are confirmed by the Revenue Sharing Agreements (RSAs), where a share of Google's advertising revenue from search goes to OEMs if the latter commits not to install rival search engines (Geradin & Edelman, 2016). This strategy makes the non-negative price constraint of two-sided market irrelevant on the producer side. Due to low marginal costs in digital markets, this results in an optimal pricing strategy with negative prices. Thus, firms could recoup their losses on the consumer side of the two-sided market (Armstrong, 2006; J. Choi & Jeon, 2018; Rochet & Tirole, 2003). Furthermore, this aspect of the case reveals intent of "naked exclusion" contracts rather than tying practices (Etro & Caffarra, 2017).

[26] Google APIs is a set of Application Programming Interfaces (APIs) developed by Google which allows communication with Google Mobile Services such as Search, Gmail, Maps or Chrome.
[27] The phone manufacturer must set "Google Search ... as the default search provider for all Web search access points." See MADA Section 3.4(4). The same requirement applies to Google's Network Location Provider service.
[28] See supra (n 1).
[29] See supra (n 1).

Google prevents the entry of competition on search engines worldwide, if MADA and RSA are present on a global scale. A possible entrant could not offer a payment to enter the market in a different country or region. In fact, the entrant would have the impossible task to bid against Google RSA on a worldwide scale (Geradin & Edelman, 2016).

The third part of the Google-Android case is the leverage of dominance in the smartphone app market to the operating system market. More concretely, an OEM which is a Google Partner (which pre-installs the "GMS package"), is required to sign an "Anti-Fragmentation Agreement" (AFA). This agreement prohibits OEMs to sell devices running on Android Forks[30] or on any modified operating systems based on Android open-source code. The firm claims that this condition helps to avoid incompatibilities between Google applications. As consequence, this restriction closes an opportunity for its OEMs to pre-install apps on operating systems which, in fact, are not owned by Google (Etro & Caffarra, 2017) and according to Geradin and Edelman (2016), the AFA makes harder for distributing a modified version of Android for any OEM because the latter "gambles" its sales if they do not sign such deal and sell Android Fork devices without GMS.

These practices combined have denied competitors the opportunity to compete on their merits and allowed Google to reinforce its market share on its search engine. Google Search and Chrome pre-installation, where the latter have Google Search as its default search engine, makes unbearable for competitors to scale through search algorithms and generate online advertising revenue. Although Google already has a substantial market share in the search engine market, the bundle has the objective to increase its sources of income, such as advertising. On two-sided platforms like Google's applications (consumers and advertisers), this is a common practice: a platform operator provides a service to users without directly charge it. Then, the operator chooses to profit from fees charged by third parties (R. H. Bork & Sidak, 2012; Geradin & Edelman, 2016). Those third parties are application developers and advertisers. The revenues come from in-app advertising plus a fixed percentage of app developers' revenues (Etro & Caffarra, 2017).

In this context, Google may increase its advertising revenue by controlling a larger share of services, by having a "Google ecosystem". In addition, on two-sided markets, exists barriers to entry mainly due to network effects: the search engine becomes more attractive

[30] Operating Systems programmed by anyone based on Android SO's open source code.

for advertisers as the number of consumers increases (Geradin & Edelman, 2016). As consequence of these three practices, Google harms competition by foreclosure the search engine market and may extend their tying benefits to influencing consumers' choices and favouring its other services (Edelman, 2015; Geradin & Edelman, 2016). Additionally, since Google face less competition in its Search engine, this would also reduce Google's incentives to invest in innovation to deter entry (Etro & Caffarra, 2017) and prevents consumers from enjoying different or even better search engines in the mobile handset industry (J. Choi & Jeon, 2018; Etro & Caffarra, 2017; Geradin & Edelman, 2016). Overall, this practices of contractual tying, approves the premise of tying for the leverage purpose (J. Choi & Jeon, 2018).

Nevertheless, Sidak (2015), author of a paper commissioned by Google, states that MADA's requirements have no anticompetitive effects, on the contrary. The contract increases the demand for mobile devices, reduce the risk of competitor's free riding on the investment of Android OS and prevents fragmentation of the GMS. Therefore, this maintains the quality of consumer experience and benefits manufacturers, advertisers, mobile carriers, consumers and app developers. As opposing view, Geradin and Edelman (2016) claim that consumers are far from "free-riding" on Google investments, exemplifying with the Google Play, where Google retains a commission of 30% when users buy an app, and YouTube, where industry analysts estimate that YouTube covers its costs with its advertising revenue (Geradin & Edelman, 2016).

Besides the reasons mentioned above, Google started to bundle its applications without charging OEMs in 2007 when the Android OS was first launched. The purpose was to persuade manufacturers and consumers to select Android services instead of Symbian or Windows mobile. Since then, Google committed to delivering an open source operative system with free application programming interface and free app store (Etro & Caffarra, 2017). This shaped a quality advantage of the Android services, as application developers choose to write their apps for Android OS. Subsequently, network effects arose, because consumers prefer an app store or operative system which offers the superior number of apps and vice-versa (Etro & Caffarra, 2017).

Etro and Caffarra (2017) suggests three potential solutions in order to solve the foreclosure effects and the entry-deterring implications of Google's tying practices. As a first measure, Google Play and GMS applications should be offered on a standalone basis and, as

Geradin and Edelman (2016) also suggests, charging OEMs a positive fee for some of Google's products. The benefits for OEMs and consumers will be the faculty of having alternative applications. Then, product differentiation which will intensify competition on the upstream level. On the next subsection, shows Google following this remedy.

As a second measure, the cessation of AFAs. This would force app and operating system developers to diversify and compete on the merits resulting in diversity of operating systems. The third measure, prohibiting Google payments to OEMs for exclusivity and prominent screen positions of GMS. Competition and innovation between search engines will be enhanced and rival search engines would be able to pay for pre-installation and outbid Google's RSA with the possibility of those payments being transferred to consumers through lower prices for the Android mobiles (Etro & Caffarra, 2017).

Alternatively, OEMs could be engaged in exclusivity contracts with rival search providers (Etro & Caffarra, 2017) or pre-installing a number of competing apps, thereby, allowing consumers to choose their default search engine by presenting them with a choice of multiple options. Through this method, pre-installation efficiencies (no installation costs for consumers) still be realised without tying (Kühn et al., 2005). This latter remedy is also one of the changes implemented by Google recently. On the following subsection, on the last paragraph, this remedy is explained with more detail.

4.1. Google's response to the European Commission decision

On the same day when the European Commission issued a decision against Android, Google's CEO Sundar Pichai wrote on the official Google Blog the intention to appeal the EC decision[31]. Google's CEO argued that the free distribution of Android OS created more flexibility, choice and opportunity to users, phone makers and app developers around the world. The compatibility rules ensure technical compatibility regardless of the device and guarantees that open-source platforms do not fragment. Therefore, giving users, developers and phone makers a reliable operative system, which runs Google's applications on every device, regardless of the phone size or manufacturer.

While the appeal was pending, Google presented three new licensing options with effect on October 29 of 2018 for all new smartphones and tablets launched in the European

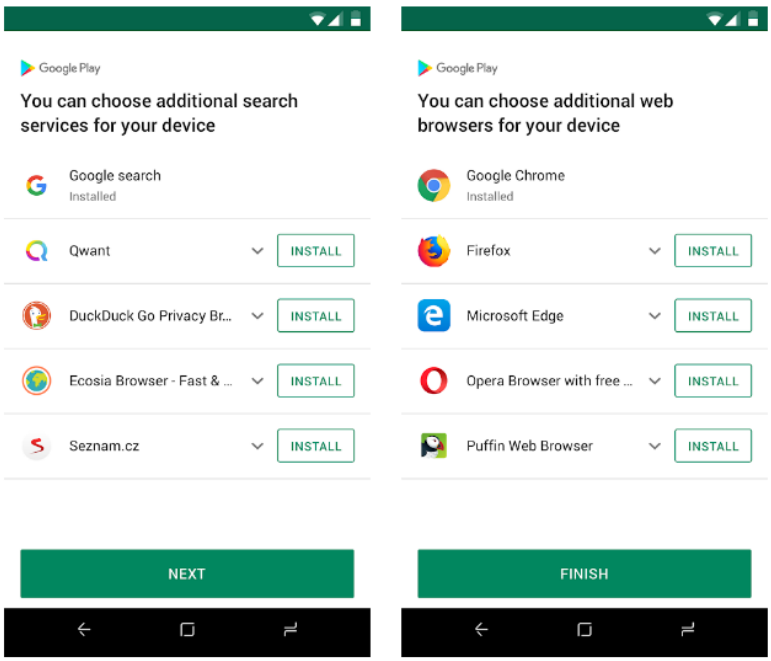
[31] See supra (n 5).

Economic Area (EEA), with the purpose of complying with the EC's decision.[32] The first change was updating the agreements with OEMs, by allowing Google partners to also sell non-compatible, or forked devices for the EEA. As the second modification, device manufacturers can license the GMS separately from Google Search or Chrome. However, since these two apps installed together was one of the reasons which allowed Android to be free, Google introduced a new paid licensing agreement for mobile devices shipped into the EEA. As the third change, Google created distinct licenses to Google Search and Chrome.

More recently, similarly to the Geradin and Edelman (2016) proposed remedy, Google announced that it will start presenting to Android users in Europe an option to download other search apps and browsers[33]. According to the technology firm, two screens will appear: one for search apps and another for browsers, each containing a total of five apps, including any that is already installed. When the user downloads a search app it is given the option to select it as the default search engine when Chrome is open. These alterations will apply to both existing and new Android phones in Europe.

Figure 1 - Search and browser options

Source: Google Blog



[32] See "Complying with the EC's Android decision". Published Oct 16, 2018. Available at https://blog.google/around-the-globe/google-europe/complying-ecs-android-decision/

[33] See "Presenting search app and browser options to Android users in Europe" Published Apr 18, 2019. Available at https://blog.google/around-the-globe/google-europe/presenting-search-app-and-browser-options-android-users-europe/

5. Model

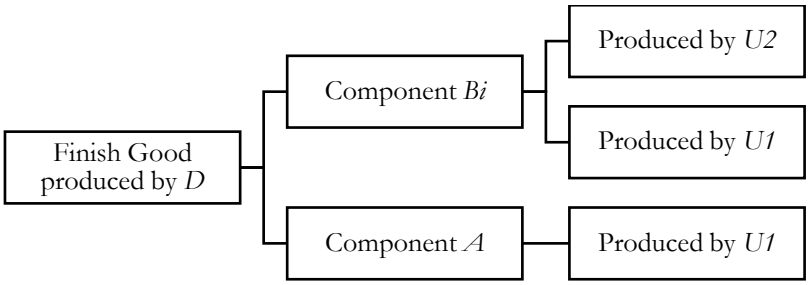
5.1. Baseline model

In this chapter, a variant of the baseline model of Cornière and Taylor (2018) is explained and presented with the objective to understand and scrutinize the Google-Android case on a theoretical Industrial Organization framework. In this dissertation, this model will serve as the foundation for the modified model with compatibility costs.

The model consists of a multiproduct upstream bundling model structured as follows: A downstream company (D) sells a finished good, made from components obtained from upstream suppliers, to final consumers at price p. The components are divided into two categories, A and B. For component A, firm U_1 is the sole producer. For component B, U_1 and U_2 firms compete to sell their own type (B_1 and B_2, respectively). Firm D can only install one version of component B.

The market in question is the smartphone market, where the components that constitute the final product are pre-installed applications and as the final product, mobile devices.

Figure 2 - Baseline Model



Cornière and Taylor (2018) assume, for brevity, that components B_1 and B_2 are perfect substitutes and essential to the final product, generating a direct revenue of nr_i for U_i from n consumers' activity on the final product $(i = 1,2)$. This revenue may come from "in-app purchases", advertising or sale of consumer data[34]. Only one B_i can be installed due to the finished good's limited capacity (i.e. only one default application can be installed for each

[34] The authors refer to this direct revenue as the efficiency of B_i component. In the rest of the dissertation, I also use the term efficiency for brevity. In a way, if one component generates more revenue allowing the upstream firm to charge a lower price (higher slotting-fee) for the component, in a general way, the last may be considered more efficient than its rival.

function and space on the mobile device's home screen) and B_i does not compete with A as they have different functions.

Our following two models are founded on the same assumptions, except that component B_i is now considered non-essential. The justification for this modification relies on the Google-Android case specificities. The tied component appears to be non-essential to OEMs mobile device' well-functioning nor affects consumer demand for mobiles devices. For example, Google only sells Google Play (A) if OEMs install conjunctively Google Chrome and Search (B_1). The demand for the finished product may change if Google Play app is not installed, because of its important services for the well-functioning of Android (Geradin & Edelman, 2016). Meanwhile, Chrome and Search applications do not affect the smartphone performance when they are not pre-installed and they can be downloaded any time after the consumer purchase the handset device.

The Demand for the finished product is designated as $Q(p, S)$, where p constitutes the price and $S \in \{\{B_i\}, \{A\}, \{A, B_i\}\}$ is the possible set of components that D may install. The authors establish the following:

i) for any given S, the revenue function of the downstream firm is $pQ(p, S)$, which is quasi-concave in p and maximized at p_S.

ii) B_1 and B_2 are perfect substitutes from consumer's perspective: $Q(p, \{A, B_1\}) = Q(p, \{A, B_2\}$ and $Q(p, \{B_1\}) = Q(p, \{B_2\})$.

The profits of the downstream firm are described as: $\Pi \equiv p_{\{A,B_i\}} Q(p_{\{A,B_i\}}, \{A, B_i\})$ when A is installed in conjunction with B_i; $\pi \equiv p_{\{B_i\}} Q(p_{\{B_i\}}, \{B_i\})$ when A is not installed alongside B_i; and $\Pi \equiv p_{\{A\}} Q(p_{\{A\}}, \{A\})$ when only component A is installed. Therefore, it is considered that component B_i does not bring any extra value for the finished product or to the downstream firm for being pre-installed. As a result, the downstream firm only installs B_i if it increases D's profit or at least if does not diminishes it. The model is constituted by two key assumptions:

Retail complementary - The finished product is more valuable when component A is installed, regardless of component B_i. In such case, more consumers buy the finished good and the downstream firm sales revenue is larger.

$$Q \equiv Q\left(p_{\{A,B_i\}}, \{A, B_i\}\right) = Q\left(p_{\{A\}}, \{A\}\right) > Q(p_{\{B_i\}}, \{B_i\}) \equiv q \quad \text{and} \quad \Pi > \pi$$

Contractual friction – Upstream firms can only receive lump-sum transfers for the installation of their components in the finished product. Nevertheless, U_i earns r_i per consumer served. Thus, upstream firms have a positive per-unit income from each consumer. The lump-sum transfers are denoted as F_X and constitute the upstream demand from D for the installation of component X. A negative value of F_X corresponds to a payment to D, that is, a slotting fee. Revealing that upstream producers are willing to pay for D to install their applications on the smartphone.

F_{B_i} represents the lump-sum transfer from the downstream firm to U_i for the installation of component B_i. F_A is the lump-sum payment from D to U_1 for the installation of component A. F_1 constitutes the lump-sum transfer from the downstream firm to U_1 for the installation of the bundle.

Payoffs:

D's profit if it installs A and B_i: $V_D = \Pi - F_A - F_{B_i}$

D's profit if it installs the A and B_1 bundle: $\hat{V}_D = \Pi - \hat{F}_1$

D's profit if only B_i is installed: $V_D = \pi - F_{B_i}$

D's profit if only A is installed: $V_D = \Pi - F_A$

U_1's profit if A and B_1 are installed: $V_1 = F_A + F_{B_1} + r_1 Q$

U_1's profit if bundle A and B_1 is installed: $\hat{V}_1 = \hat{F}_1 + r_1 Q$

U_1's profit if only B_1 is installed: $V_1 = F_{B_1} + r_1 q$

U_1's profit if only A is installed: $V_1 = F_A$

U_2's profit if B_2 is installed alongside A: $V_2 = F_{B_2} + r_2 Q$

U_2's profit if B_2 is installed without A: $V_2 = F_{B_2} + r_2 q$

Timing: At $t = 0$, U_1 announces whether it bundles A and B_1. At $t = 1$, upstream firms make simultaneous offers to the downstream firm (F_A, F_{B_i}, F_1). At $t = 2$, the downstream firm decides which component(s) to install and chooses a final price (S, p). At $t = 3$, payoffs are realized. The attention is restricted to the subgame-perfect equilibria and this dissertation study the two subgames without bundling and with bundling in turn.

5.2. Model with timing modification

Using the model of Cornière and Taylor (2018) with the same assumptions (except B_i is a non-essential component) cited on the previous subsection, the sequence of the negotiations is modified in order to verify if the same results hold. More concretely, if bundling continues to be strictly necessary in order to capture the global value of component A, if bundling reduces U_2's willingness of paying slotting fees and lastly, how U_2 deciding secondly affects the optimal decision of U_1 to bundle.

New timing: At $t = 0$, U_1 announces whether it bundles A and B_1. At $t = 1$, U_1 make an offer to the downstream firm for the installation of components A and B_1 (F_A, F_{B_1}, F_1). At $t = 2$, U_2 make an offer to the downstream firm for the installation of component B_2 (F_{B_2}). At $t = 3$, the downstream firm decides which component(s) to install and chooses a final price (S, p). Payoffs are realized at $t = 4$.

There are four possible decisions for U_1 to maximize its profit: Sell only component A; sell only B_1; sell A and B_1 in separate marketing; or bundle A and B_1 together.

Scenario 1) U_1 only sells A.

i) U_1 *offers* $F_A = \Pi - \pi$

ii) U_2 *offers* $F_{B_2} = 0 - \epsilon$[35]

iii) *Upstream firm's profits are* $V_1 = \Pi - \pi$ *and* $V_2 = Qr_2$ *and downstream firm's profit is* $V_D = \pi$.

Proof. **i)** For D to be indifferent between choosing the components A and B_2 or only installing the component B_2: $\Pi - F_A - F_{B_2} \geq \pi - F_{B_2} \Leftrightarrow F_A \leq \Pi - \pi$. Thus, $F_A = \Pi - \pi$ is the maximum lump-sum payment that U_1 could demand for profit maximization and for A to be installed. **ii)** Alternatively, in case of D being indifferent between A and B_2 or none: $\Pi - F_A - F_{B_2} \geq 0 \Leftrightarrow \Pi - \Pi + \pi - F_{B_2} \geq 0 \Leftrightarrow F_{B_2} \leq \pi$. And for D to be indifferent between installing B_2: $\Pi - F_A - F_{B_2} \geq \Pi - F_A \Leftrightarrow F_{B_2} \leq 0$. Therefore, firm U_2 face no competition and offer the minimum slotting fee $F_{B_2} = 0$. **iii)** The upstream firm's

[35] ϵ represents the minimal size of price change. The ϵ is removed from the remainder of this model, because it does not change the equilibrium, although it is necessary to it. That is, the most efficient firm could offer ϵ and representing a Pareto improvement of the least efficient firm' offer.

profits are $V_1 = F_A$ and $V_2 = F_{B_2} + Qr_2$ and downstream firm's profit is $V_D = \Pi - F_A - F_{B_2}$. ■

This strategy allows U_1 to capture the *direct value* of component A ($\Pi - \pi$) but U_2 becomes the sole seller in the market of component B_i. Then, since firm U_1's monopoly profit in the market A it is already secured, this is not its finest strategy, because it cannot capture the *indirect value* of A[36] $(Q - q)$ nor the profit for selling B_1. U_2 cannot charge π for B_2 installation because the latter component is non-essential. Therefore, D only installs B_2 if it maintains or increases its profit.

Scenario 2) U_1 only sells B_1 ($r_i \geq r_j$).

i) U_i *offers* $F_{B_i} = -r_j q$

ii) U_j*'s rejected offer is* $F_{B_j} = -r_j q$

iii) $V_i = q(r_i - r_j)$ *and* $V_D = \pi + min\{r_1, r_2\}q$

Proof. i) In order to D install B_i instead of B_j: $\pi - F_{B_i} \geq \pi - F_{B_j} \Leftrightarrow F_{B_i} \leq F_{B_j}$. In the absence of component A, the quantity of final products sold it will be q. Therefore $F_{B_i} = -r_j q$ because it is the maximum offer that U_j could afford. **ii)** $F_{B_j} = -r_j q$ because any offer under $-r_j q$ will make U_j incur in losses. **iii)** U_i's profit is $V_i = F_{B_i} + r_i q = -q r_j + r_i q = q(r_i - r_j)$ and D's profit is $V_D = \pi - F_{B_i} = \pi + min\{r_1, r_2\}q$. ■

U_1's profit in this scenario is the lowest compared to its profits with other strategies. Moreover, the success of U_1 on installing B_1 will depend on the efficiency[37] of the components (r_1, r_2). Therefore, in this scenario, U_1 would be "betting" on its efficiency and tossing away its monopoly profit on market A.

Scenario 3) U_1 sells A and B_1 in separate marketing ($r_i \geq r_j$).

i) U_j*'s rejected offer is* $F_{B_j} = -r_j Q$

[36] See Scenario 3, for further explanation about the *direct* and *indirect value* of component A.

[37] B_i's efficiency is denoted by r_i, but is the same as saying unit revenue of B_i. In other words, if U_i firm can offer better slotting fees because of its higher revenues it is more efficient.

ii) U_i *offers* $F_{B_i} = -r_j Q$

iii) U_1 *offers* $F_A = \Pi - \pi$

iv) *If* $r_1 \geq r_2$ U_1*'s profit is* $V_1 = \Pi - \pi + Q(r_1 - r_2)$. *If* $r_1 < r_2$, *it is* $V_1 = \Pi - \pi$ *and* U_2*'s profit is* $V_2 = Q(r_2 - r_1)$. *The downstream firm's profit is* $V_D = \pi + min\{r_1, r_2\}Q$ *in both cases.*

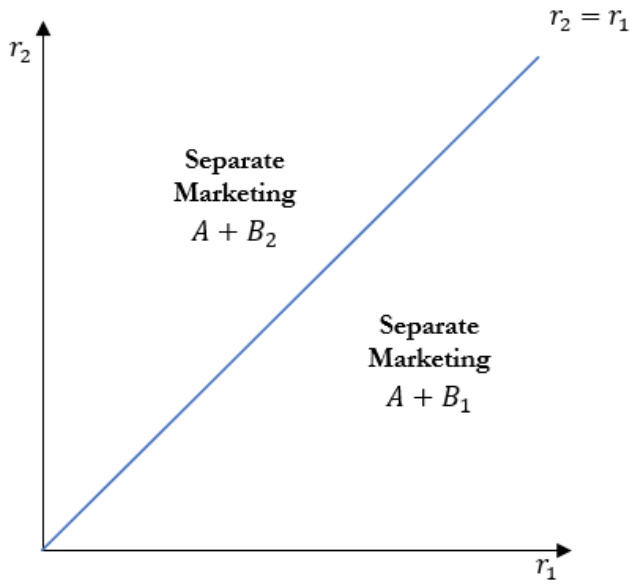
Proof. i) U_j knows that A could be installed alongside B_j, then $F_{B_j} = -r_j Q$ is the maximum offer (minimum value) without incurring in any losses. **ii)** There are two situations where D is indifferent between installing B_i**:** First, in order to D install A and B_i instead of A and B_j: $\Pi - F_A - F_{B_i} \geq \Pi - F_A - F_{B_j} \Leftrightarrow F_{B_i} \leq F_{B_j} \Leftrightarrow F_{B_i} \leq -r_j Q$. Second, for D prefers to install A and B_i over component A: $\Pi - F_A - F_{B_i} \geq \Pi - F_A \Leftrightarrow F_{B_i} \leq 0$. Thus, the maximum offer that U_i will make for B_i is the maximum slotting fee of the least efficient firm (U_j), which is $F_{B_i} = -r_j Q$. **iii)** Assuming that D wants to install A and B_i instead of only B_j: $\Pi - F_A - F_{B_i} \geq \pi - F_{B_j} \Leftrightarrow F_A \leq \Pi - \pi - F_{B_i} + F_{B_j}$. And, in order to D prefers to install A and B_i instead of B_i alone: $\Pi - F_A - F_{B_i} \geq \pi - F_{B_i} \Leftrightarrow \Pi - \pi \leq F_A$. Then, $F_A = \Pi - \pi$ is the best profit maximization offer that U_1 could make for A to be installed. **iv)** U_1's profit is $V_1 = F_A + F_{B_1} + r_1 Q = \Pi - \pi + Q(r_1 - r_2)$ if $r_1 \geq r_2$. If $r_1 < r_2$, $V_1 = \Pi - \pi$ and U_2's profit is $V_2 = Q(r_2 - r_1)$. In both cases, the downstream firm's profit is $V_D = \pi + min\{r_1, r_2\}Q$. ■

When $r_1 < r_2$ the firm U_2 have two similar profits under separate marketing: When U_1 sells A and B_1, it has $V_2 = Q(r_2 - r_1)$ and when U_1 only sell only B_1, it has $V_2 = q(r_2 - r_1)$. **Although the profits are slightly different, they have the same logic behind it**. The difference of the efficiencies of B_2 and B_1 ($r_1 < r_2$) allows U_2 to offer a slightly better slotting fee than U_1, which is sufficient for D to choose the component B_2 over B_1. The two profits only differ in Q and q, due to component A being installed alongside B_i or not. Although, despite this difference in quantities component B_2 is pre-installed in both scenarios.

The downstream firm's decision of installing component B_i dependent on r_i is represented graphically in Figure 3. The curve $r_1 = r_2$ represents D's indifference curve, that is, the condition where the downstream firm has the same profits if installs either A with B_1 or A with B_2. In other words, the line where firm D is indifferent between choosing the two

latter options. Thus, if $r_1 > r_2$, the downstream firm installs A with B_1 and if $r_1 < r_2$, D installs A with B_2, as the proof demonstrates.[38]

Figure 3 – Installed components under separate marketing



Through the three preceding scenarios it is inferred that **when component A is installed, it adds value to the finished product by two ways**. Through *direct value* ($\Pi - \pi$), where the firm U_1 can capture this value by offering $F_A = \Pi - \pi$, and through *indirect value* $(Q - q)$ to the downstream firm, since A increase the willingness of B_i firms to pay slotting fees because U_i knows that if A is installed their revenue grow from qr_i to Qr_i,.

Nevertheless, **U_1 cannot capture the indirect value of A through separated marketing.** For U_1 to be able to capture the global value by separate marketing, it is necessary that U_2 does not offer $F_{B_2} < -qr_2$, meaning that, U_2 has to offer $F_{B_2} = -qr_2$ instead of $F_{B_2} = -Qr_2$. For such offer to take place, firm U_2 must expect that B_2 cannot be installed alongside with A, and for that to happen D must prefer to install only B_2 instead of A with B_2: $\Pi - F_A - F_{B_2} < \pi - F_{B_2} \Leftrightarrow F_A > \Pi - \pi$. Thus, when U_2 observes $F_A > \Pi - \pi$, it will offer $F_{B_2} = -qr_2$. However, if U_1 offers $F_A > \Pi - \pi$, the downstream firm does not acquire A and installs only B_i. Thus, bundling is necessary to capture the global value of A.

[38] Scenario 2 has the same reasoning behind D's choice of B_i components, the only difference is that component A is absent. Therefore, this curve represents, in the same way, the D's indifferent curve.

Scenario 4) U_1 bundles A and B_1 together.

i) *Firm* U_1 *offers* $\hat{F}_1 = \Pi - \pi + \hat{F}_{B_2}$

ii) *Firm* U_2 *offers* $\hat{F}_{B_2} = -qr_2$

iii) *Downstream firm's profit is* $\hat{V}_D = \pi + qr_2$. *Firm* U_1 *profit is* $\hat{V}_1 = \Pi - \pi - qr_2 + r_1 Q$

Proof. i) In order to D accept the bundle instead of only installing component B_2: $\hat{V}_D \geq V_D \Leftrightarrow \Pi - \hat{F}_1 \geq \pi - \hat{F}_{B_2} \Leftrightarrow \hat{F}_1 \leq \Pi - \pi + \hat{F}_{B_2}$. Therefore, $\hat{F}_1 = \Pi - \pi + \hat{F}_{B_2}$ because it is the maximum value which U_1 could charge to make D indifferent between installing the two options. **ii)** U_2 anticipates, on a bundling scenario, that B_2 cannot be installed alongside A, meaning that the number of sales of the finished product when component B_2 is installed is q. Thus, $\hat{F}_{B_2} = -qr_2$ is the best offer that U_2 could afford, without incurring in any losses. **iii)** Upstream firm's profit is $\hat{V}_1 = \hat{F}_1 + r_1 Q = \Pi - \pi - qr_2 + r_1 Q$ and downstream firm's profit is $\hat{V}_D = \Pi - \hat{F}_1$. ■

Through bundling, U_1 has now the capability of capturing the global value of A**.** Also, **bundling relaxes B_i competition as it decreases U_2's willingness to pay slotting fees for the installation of B_2**. When U_1 decides to bundle, firm U_2 knows that B_2 cannot be installed alongside component A. Consequently, if B_2 is installed, the demand for the finished product it will be lower than the demand for the finished product with component A installed, that is, the revenue of U_2 will be qr_2 instead of Qr_2. Thus, in the presence of bundling, U_2's slotting fee is reduced from Qr_2 to qr_2.

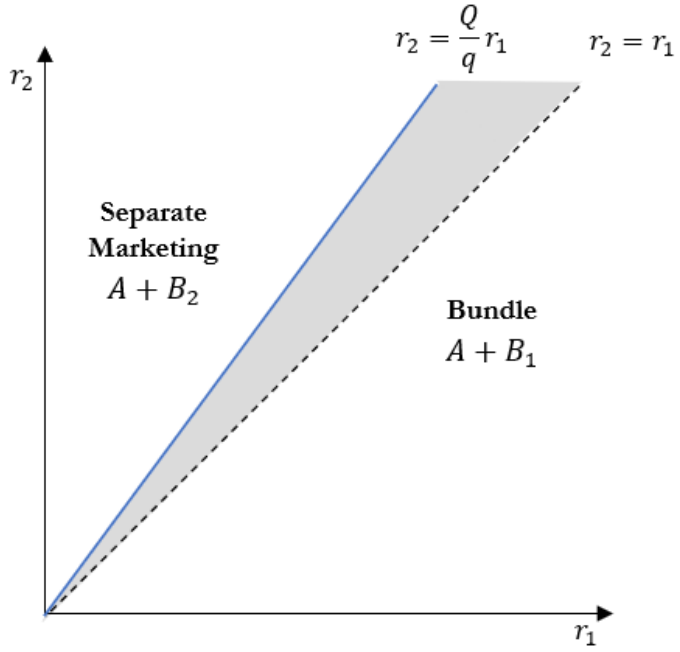
From the **downstream firm's perspective, the more profitable scenario is when U_1 sells both products in separate marketing** ($V_D = \pi + min\{r_1, r_2\}Q$). This result occurs due to the increased competition on B_i market, which compels the upstream firms to offer their highest slotting fee possible, and due to the possibility of component A being installed alongside B_2, which produce the indirect value, which U_1 cannot capture through separate marketing.

$\hat{F}_{B_2} = -qr_2$ is the best offer that U_2 could afford, without incurring in any losses on a bundling scenario. Although, supposing $r_1 < r_2$, would $\hat{\mathrm{F}}_{\mathrm{B}_2} = -qr_1$ be feasible and what

is D' response? Expressly, **how r_1 and r_2 impact the optimal decision of U_1 to bundle A and B_1?** When $r_1 \geq r_2$ it is already known from previous calculations that bundling is, as expected, the most profitable strategy for U_1 than any other strategy ($\hat{V}_1 > V_{1_{A+B_1}} > V_{1_A} > V_{1_{B_1}}$)[39]. Hence, it is important to know what is the best strategy for U_1 when $r_1 < r_2$.

If $r_1 < r_2$, U_1's more profitable options are bundling or selling only component A. Why only those two options? Because the downstream firm will always accept F_{B_2} over F_{B_1} when U_1 sells A and B_1 in separate marketing[40] or when U_1 only sells B_1. Therefore, as $V_{1_{A+B_1}} = V_{1_A} > V_{1_{B_1}}$ the upstream firm U_1 will only choose between bundling or selling only component A. In summary, U_1 bundles when $\hat{V}_1 \geq V_{1_A} \Leftrightarrow \Pi - \pi - qr_2 + r_1 Q \geq \Pi - \pi \Leftrightarrow r_1 Q \geq qr_2 \Leftrightarrow \frac{r_1}{r_2} \geq \frac{q}{Q}$.

Figure 4 – Installed components and optimal bundling decision



$\hat{F}_{B_2} = -qr_1$ may not be feasible, even $r_1 < r_2$ on a bundling setup, because U_2 and U_1 still have margin for improving their offers. Since they are in Bertrand competition, both firms will offer the best price (slotting fee) until one or both firms reach null profits (bids its maximum offer). In this case, $\hat{F}_{B_2} = -qr_2$ is U_2's maximum offer and U_1 offers $\hat{F}_1 = \Pi -$

[39] $\hat{V}_1 = \Pi - \pi - qr_2 + r_1 Q;\ V_{1_{A+B_1}} = \Pi - \pi + Q(r_1 - r_2);\ V_{1_A} = \Pi - \pi;\ V_{1_{B_1}} = q(r_i - r_j)$.

[40] Scenario 3, where $V_{1_{A+B_1}} = V_{1_A} = \Pi - \pi$.

$\pi - qr_2 + r_1Q$ leaving D indifferent between installing both options, but as U_1 has the faculty of offering a slightly better slotting fee, D installs B_1. Although, if $r_2 > \frac{Q}{q}r_1$ the U_2 firm will offer $F_{B_2} = -qr_1$, but in this case U_2 has no competition because U_1 choose to only sell A. Therefore when $r_2 \leq \frac{Q}{q}r_1$ the most profitable strategy for firm U_1 is to bundle and D installs the bundle. Although, when $r_2 > \frac{Q}{q}r_1$ the optimal option for U_1 is to sell only A and the downstream firm installs A and B_2 through separate marketing.

In this scenario, the blue curve from Figure 4 $\left(r_2 = \frac{Q}{q}r_1\right)$ represents the downstream firm's indifference between installing the bundle or installing only component B_2. Nonetheless, contrary to the previous scenario, the curve also signifies the limit of the optimality of U_1's bundling decision. In other words, it represents the limit value of r_2 that stops bundling from being the most profitable strategy for U_1. Therefore, when $r_2 > \frac{Q}{q}r_1$, the graph shows separate marketing with A and B_2 instead of only component B_2, because in such circumstance, although D reject the bundle, U_1 only sell component A.

Bundling has anticompetitive effects because when U_1 sells A and B_1 in separate marketing, U_2 only need to guarantee that $Qr_2 > Qr_1$ for B_2 to be installed and have profit. Meanwhile, when U_1 bundles, the previous condition is not sufficient. U_2 have now to ensure that $qr_2 > Qr_1$ for B_2 to be installed. Meaning that the efficiency of B_2 (r_2) must now be greater than the efficiency of B_1 by the proportion of the increase in sales that component A causes when installed (Q/q). From the downstream firm's perspective, D is indifferent between installing B_1 or B_2 if $r_2 = r_1$ in separate marketing. Nonetheless, when U_1 bundles its two components, the component B_1 becomes more attractive to D because installing B_2 implies not installing A. Therefore, when faced with the bundle option, the downstream firm only becomes indifferent between B_1 or B_2 if $r_2 = \frac{Q}{q}r_1$. This change of D's indifference is represented by the increase of slope on D's indifference curve from $r_2 = r_1$ to $r_2 = \frac{Q}{q}r_1$, resulting in the grey area which characterises the anticompetitive effect.

The anticompetitive effect (grey area) is quantified by $r_2(Q-q)$. This value represents the difference between the two curves[41] which is the exact same value of U_1's profit increase when it bundles compared to its second most profitable option, selling A and B_1 in separate marketing. $r_2(Q-q)$ is also the value of U_2's profit decrease. Hence, U_1 can capture the indirect value of $A\ r_2(Q-q)$ and leverage its dominance in market A to increase its profits in market B_i.

5.3. Model with compatibility costs

On the previous chapter, I confirm the Cornière and Taylor (2018) results with additional methods and interpretations through the timing and assumption modifications. Hence, the previous chapter is helpful for the building of the following adjustment which attempts to approximate the baseline model to the reality of Google-Android case.

On the intention to appeal the European Commission's decision, Google alleged that the contractual tying of Google Play, Google Search and Chrome ensures technical compatibility for device manufacturers and consumers regardless the device, due to its Google APIs (Geradin & Edelman, 2016). Furthermore, the presence of Google Search and Chrome applications is the major reason why Android is free for OEMs[42]. Lastly, the MADAs prevents the fragmentation of the open-source platforms by maintaining the "Google ecosystem", otherwise the quality of consumer experience is degraded (Sidak, 2015).

Therefore, in order to embody the alleged incompatibility problems that Google's rival applications (B_2) incur when they are pre-installed instead of other GMS apps such as Google Search or Chrome (B_1) and the increase of funds that the latter two apps cause when installed together with Google Play (A), I introduce the assumption that there are synergies for U_1 when component B_1 is installed alongside A. In other words, U_1 does not face compatibility costs when D installs B_1 alongside A, because both components belong to the same "ecosystem". Meanwhile, since B_2 is not perfectly harmonized with component A nor the operative system of the finished product. So, its pre-installation results in compatibility costs.

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[41] The difference between two curves is $(Qr_1 = Qr_2 \ and \ r_2 = \frac{Q}{q}r_1 \Leftrightarrow qr_2 = Qr_1)$ is $Qr_2 - qr_2 = r_2(Q-q)$.

[42] See supra (n 5).

In the same way as the baseline model, there are four possible decisions for U_1 to maximize its profit: selling only component A; selling only B_1; selling both components in separate marketing; or bundle A and B_1 together

Payoffs:

D's profit if it installs A and B_i: $V_D = \Pi - F_A - F_{B_i}$

D's profit if it installs the A and B_1 bundle: $\hat{V}_D = \Pi - \hat{F}_1$

D's profit if only B_i is installed: $V_D = \pi - F_{B_i}$

D's profit if only A is installed: $V_D = \Pi - F_A$

U_1's profit if A and B_1 are installed: $V_1 = F_A + F_{B_1} + r_1 Q$

U_1's profit if the bundle A and B_1 is installed: $\hat{V}_1 = \hat{F}_1 + r_1 Q$

U_1's profit if only B_1 is installed: $V_1 = F_{B_1} + r_1 q - c$

U_1's profit if only A is installed: $V_1 = F_A$

U_2's profit if B_2 is installed alongside A: $V_2 = F_{B_2} + r_2 Q - c$

U_2's profit if B_2 is installed without A: $V_2 = F_{B_2} + r_2 q - c$

Scenario 1) U_1 only sells A.

i) U_1 *offers* $F_A = \Pi - \pi$

ii) U_2 *offers* $F_{B_2} = 0$

iii) *Upstream firm's profits are* $V_1 = \Pi - \pi$ *and* $V_2 = Qr_2 - c$ *and downstream firm's profit is* $V_D = \pi$.

Proof. i) For D to be indifferent between choosing the components A and B_2 or only installing the component B_2: $\Pi - F_A - F_{B_2} \geq \pi - F_{B_2} \Leftrightarrow F_A \leq \Pi - \pi$. Thus, $F_A = \Pi - \pi$ is the maximum value that U_1 could demand for A. **ii)** Alternatively, in case of D being indifferent between A and B_2 or none: $\Pi - F_A - F_{B_2} \geq 0 \Leftrightarrow \Pi - \Pi + \pi - F_{B_2} \geq 0 \Leftrightarrow F_{B_2} \leq \pi$. Also, for D to be indifferent between installing B_2: $\Pi - F_A - F_{B_2} \geq \Pi - F_A \Leftrightarrow F_{B_2} \leq 0$. Therefore, as firm U_2 face no competition it does not offer slotting fees, but the maximum it can demand for B_2 installation is $F_{B_2} = 0$. Any value above, D does not install

B_2. **iii)** The upstream firm's profits are $V_1 = F_A$ and $V_2 = F_{B_2} + Qr_2 - c$ and downstream firm's profit is $V_D = \Pi - F_A - F_{B_2} = \Pi - \Pi + \pi - 0 = \pi$. ■

This scenario is identical to its homologous on the previous model, in terms of U_1's payoff and the logic behind F_A. **As expected, U_2's compatibility cost does not affect U_1's profitability of market A**. However, U_2's profit is smaller due to the cost incurred, because its lump-sum payment remains equal to zero. $F_{B_2} = 0$ is the maximum value that D accepts to pay for the pre-installation of B_2. Therefore, U_2 cannot charge $F_{B_2} = c$, with the objective of transferring the cost to D, because the downstream firm would reject it and would choose to pre-install A alone.

Scenario 2.) U_1 only sells B_1 ($r_i \geq r_j$).

i) U_i *offers* $F_{B_i} = -r_j q + c$

ii) U_j*'s rejected offer is* $F_{B_j} = -r_j q + c$

iii) $V_i = q(r_i - r_j)$ *and* $V_D = \pi + min\{r_1, r_2\}q - c$

Proof. i) In order to D install B_i instead of B_j: $\pi - F_{B_i} \geq \pi - F_{B_j} \Leftrightarrow F_{B_i} \leq F_{B_j}$. In the absence of component A, the quantity of final products sold it will be q and both B_1 and B_2 incur in compatibility costs. Therefore $F_{B_i} = -r_j q + c$ is accepted, because U_i still has margin for improving its offer by a minimum value which results in a Pareto improvement for D. **ii)** $F_{B_j} = -r_j q + c$ because any offer under $-r_j q + c$ would make U_j incur in losses. **iii)** U_i's profit is $V_i = F_{B_i} + r_i q - c = -qr_j + r_i q = q(r_i - r_j)$ and D's profit is $V_D = \pi - F_{B_i} = \pi + min\{r_1, r_2\}q - c$. ■

The compatibility cost is transferred to the downstream firm independently from $r_i \geq r_j$. For U_j to not incur in losses, it must charge c to firm D through its slotting fee and, since the best maximization profit strategy for U_i is to $F_{B_i} \leq F_{B_j}$, the firm U_i also reduces its slotting fee by c. Therefore, the cost is borne by the downstream firm through the reduction of B_i's slotting fees by c.

Correspondingly to the previous model, this scenario is purely hypothetical since U_1's profit is the lowest compared to all other strategies. In addition, the success of U_1 on

installing B_1 will depend on the efficiency of the components (r_1, r_2). Therefore, in this scenario U_1 would be "betting" on its efficiency, incurring in compatibility costs due to A's absence and tossing away its monopoly profit on the market A.

Scenario 3.1.) U_1 sells A and B_1 in separate marketing ($r_1 \geq r_2$)

i) U_1 *accepted offer is* $F_{B_1} = -r_2Q + c$

ii) U_2*'s rejected offer is* $F_{B_2} = -r_2Q + c$

iii) $F_A = \Pi - \pi$ *is accepted*

iv) U_1*'s profit is* $V_1 = \Pi - \pi + Q(r_1 - r_2) + c$ *and downstream firm's profit is* $V_D = \pi + r_2Q - c$[43]

Proof i) There are two situations where D is indifferent between installing B_1**:** First, in order to D install A and B_1 instead of A and B_2: $\Pi - F_A - F_{B_1} \geq \Pi - F_A - F_{B_2} \Leftrightarrow F_{B_1} \leq F_{B_2} \Leftrightarrow F_{B_1} \leq -r_2Q + c$. Second, for D prefers to install A and B_1 over component A : $\Pi - F_A - F_{B_1} \geq \Pi - F_A \Leftrightarrow F_{B_1} \leq 0$. Thus, the offer that U_1 will make for B_1 it is the maximum offer of the least efficient firm, $F_{B_1} = -r_2Q + c$. This offer is accepted because U_1 still have margin for improving its offer and U_2 does not. **ii)** U_2 knows that A could be installed alongside B_2 and incurs in cost c. Thus, U_2 needs to recoup c through the slotting fee, or else will incur in losses ($V_2 = r_2Q - c + F_{B_2}$). Therefore, $F_{B_2} = -r_2Q + c$. **iii)** Assuming that D wants to install A and B_1 instead of only B_2: $\Pi - F_A - F_{B_1} \geq \pi - F_{B_2} \Leftrightarrow F_A \leq \Pi - \pi - F_{B_1} + F_{B_2}$. And, in order to D prefers to install A and B_1 instead of B_1 alone: $\Pi - F_A - F_{B_1} \geq \pi - F_{B_1} \Leftrightarrow \Pi - \pi \leq F_A$. Then, $F_A = \Pi - \pi$ is the best profit maximization offer that U_1 could make for A to be installed **iv)** U_1's profit is $V_1 = F_A + F_{B_1} + r_1Q = \Pi - \pi + Q(r_1 - r_2) + c$ and U_2's profit is $V_2 = r_2Q - c + F_{B_2} = r_2Q - c - r_2Q + c = 0$. The downstream firm's profit is $V_D = \Pi - F_A - F_{B_i} = \pi - c + r_2Q$. ■

[43] I assume that U_2's total revenue is higher than the compatibility cost $r_2Q > c$. Otherwise, there would not be any logical explanation for U_2 to belong in the B_i market.

Scenario 3.2.) U_1 sells A and B_1 in separate marketing ($r_1 < r_2$).

i) U_1*'s accepted offer is* $F_{B_1} = -r_1Q + c - Q(r_2 - r_1)$ *if* $c > Q(r_2 - r_1)$ *and* $F_{B_1} = -r_1Q$ *is rejected if otherwise.*

ii) U_2*'s accepted offer is* $F_{B_2} = -r_1Q$ *if* $c \leq Q(r_2 - r_1)$ *and* $F_{B_2} = -r_1Q + c - Q(r_2 - r_1)$ *is rejected if otherwise.*

iii) $F_A = \Pi - \pi$ *is accepted in both cases.*

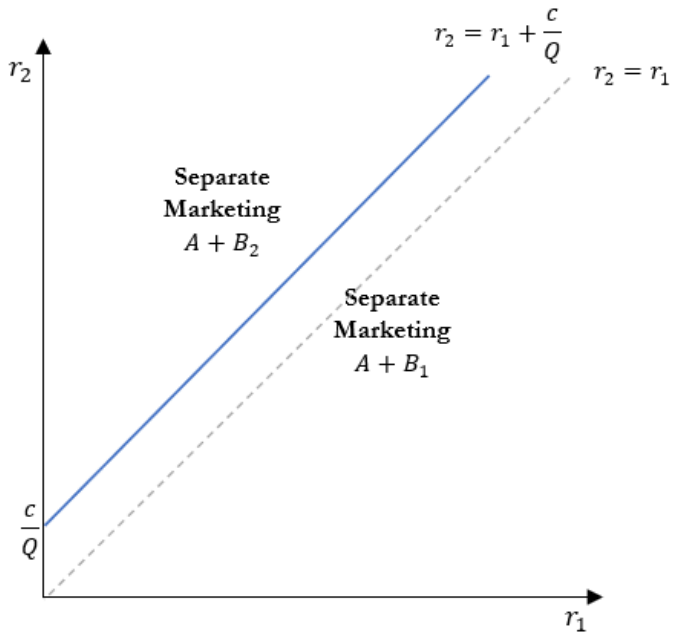
iv) If $c > Q(r_2 - r_1)$: U_1*'s profit is* $V_1 = \Pi - \pi + c - Q(r_2 - r_1)$ *and D's profit is* $V_D = \pi + r_2Q - c$. *If* $c \leq Q(r_2 - r_1)$*:* U_1*'s profit is* $V_1 = \Pi - \pi$, U_2*'s profit is* $V_2 = Q(r_2 - r_1) - c$ *and downstream firm's profit is* $V_D = \pi + r_1Q$.

Proof. i) In order to D install A and B_1 instead of A and B_2: $\Pi - F_A - F_{B_1} \geq \Pi - F_A - F_{B_2} \Leftrightarrow F_{B_1} \leq F_{B_2}$. Assuming if $F_{B_2} = F_{B_1} = -r_1Q + c$ it remains a margin for improvement of both offers. In asymmetric Bertrand competition the least efficient firm has null profits. In this case, both have profits. $V_2 = F_{B_2} - c + Qr_2 = Q(r_2 - r_1)$ and $V_{B_1} = c$. Thus, it is observable that U_1 could increase its slotting fee by c and U_2 could increase its slotting fee by $Q(r_2 - r_1)$. Nevertheless, it is unknown if the compatibility cost incurred by U_2 is superior to the difference between B_i and B_j revenues. Thus, it surges two cases: First, if $c > Q(r_2 - r_1)$, U_1 offers $F_{B_1} = -r_1Q + c - Q(r_2 - r_1)$ and D accepts it because U_1 still have margin for improvement of its offer which is equal to U_2's maximum slotting fee $F_{B_2} = -r_1Q + c - Q(r_2 - r_1)$. **ii)** Second, if $c \leq Q(r_2 - r_1)$, U_2 offers $F_{B_2} = -r_1Q$ and it is accepted by D, since U_1 only could offer $F_{B_1} = -r_1Q$ and any value above will incur in losses for selling B_1. **iii)** Same logic explanation of Scenario 3.1. **iv)** If $c > Q(r_2 - r_1)$, U_1's profit is $V_1 = F_A + F_{B_1} + r_1Q = \Pi - \pi - r_1Q + c - Q(r_2 - r_1) + r_1Q = \Pi - \pi + c - Q(r_2 - r_1)$, U_2's profit is $V_2 = r_2Q - c + F_{B_2} = r_2Q - c - r_1Q + c - Q(r_2 - r_1) = 0$ and $V_D = \Pi - F_A - F_{B_1} = \Pi - \Pi + \pi + r_1Q - c + r_2Q - r_1Q = \pi + r_2Q - c$. If $c \leq Q(r_2 - r_1)$, U_1's profit is $V_1 = F_A + F_{B_1} + r_1Q = \Pi - \pi - r_1Q + r_1Q = \Pi - \pi$, U_2's profit is $V_2 = r_2Q - c + F_{B_2} = r_2Q - c - r_1Q = Q(r_2 - r_1) - c$ and downstream firm's profit is $V_D = \Pi - F_A - F_{B_2} = \Pi - \Pi + \pi + r_1Q = \pi + r_1Q$. ■

U_1 takes advantage of U_2's compatibility cost to reduce its slotting fee and improving its profits in the same amount. Consequently, the cost is borne by the downstream firm again through the reduction of B_i's slotting fees by c when $r_1 \geq r_2$ and by

$c - q(r_2 - r_1)$ when $r_1 < r_2$ and $c > q(r_2 - r_1)$. The cost is only loaded by an upstream firm when $c \leq q(r_2 - r_1)$, making U_2's profit $V_2 = q(r_2 - r_1) - c$. In Scenarios 3.1 and 3.2, U_1 faces no compatibility cost as a result of the synergy caused by B_1 being pre-installed in conjunction with component A.

Figure 5 – Installed components under separate marketing with compatibility costs



Similarly to the original model, selling both components is the most profitable strategy for U_1 as an alternative to bundling. Although, in this model it remains the more profitable option independently from $r_i \geq r_j$, if $c > Q(r_2 - r_1)$. Therefore, the downstream firm's indifference curve has moved to the left by c/Q.[44] Meaning, that in separate marketing, **even when U_2 has a more efficient component ($r_1 < r_2$), it does not guarantee the pre-installation of the B_2**. Nevertheless, equally to the original model, U_1 cannot capture the global value of component A in separate marketing.

Scenario 4) U_1 bundles A and B_1

iv) *Firm* U_1 *offers* $\hat{F}_1 = \Pi - \pi + \hat{F}_{B_2}$

[44] $c = Q(r_2 - r_1) \Leftrightarrow r_2 = r_1 + \frac{c}{Q}$.

v) *Firm* U_2 *offers* $\hat{F}_{B_2} = -qr_2 + c$

vi) *Downstream firm's profit is* $\hat{V}_D = \pi + qr_2 - c$. *Firm* U_1*'s profit is* $\hat{V}_1 = \Pi - \pi - qr_2 + r_1 Q + c$

Proof. i) The downstream firm accepts the bundle instead of only installing component B_2 if: $\hat{V}_D \geq V_D \Leftrightarrow \Pi - \hat{\mathrm{F}}_1 \geq \pi - \hat{\mathrm{F}}_{\mathrm{B}_2} \Leftrightarrow \hat{\mathrm{F}}_1 \leq \Pi - \pi + \hat{\mathrm{F}}_{\mathrm{B}_2}$. Therefore, $\hat{\mathrm{F}}_1 = \Pi - \pi + \hat{\mathrm{F}}_{\mathrm{B}_2}$ because it is the maximum value which U_1 could demand to make D indifferent between installing the two options. **ii)** U_2 anticipates that on a bundling scenario B_2 cannot be installed alongside A and will incur with c. Thus, $\hat{F}_{B_2} = -qr_2 + c$ is the best offer that U_2 could afford, without incurring in any losses. **iii)** Upstream firm's profit is $\hat{V}_1 = \hat{F}_1 + r_1 Q = \Pi - \pi - qr_2 + c + r_1 Q$ and downstream firm's profit is $\hat{V}_D = \Pi - \hat{F}_1$. ■

Bundling is the best profit maximization strategy for U_1 since it can capture the indirect $(Q - q)$ and direct value $(\Pi - \pi)$ of component A installation. Furthermore, since B_2 cannot be installed alongside A, bundling reduces U_2's willingness to pay slotting fees. When we compare this bundling profit to its homologous in the original model, **bundling reveals to be even more profitable in presence of compatibility costs,** because the cost is transferred to the downstream firm through the reduction of upstream firm's slotting fees by c, similarly to the previous scenario. Although, when the bundling profit is compared to the profit of selling A and B_1 in separate marketing, $\boldsymbol{U_1}$ **presents the same profit increase of** $\boldsymbol{r_2(Q - q)}$**, exactly as the original model, regardless of** $\boldsymbol{r_i \geq r_j}$ [45]. Therefore, having or not having synergies in the joint pre-installation of the components, bundling causes the same profit increase when compared to separate marketing.

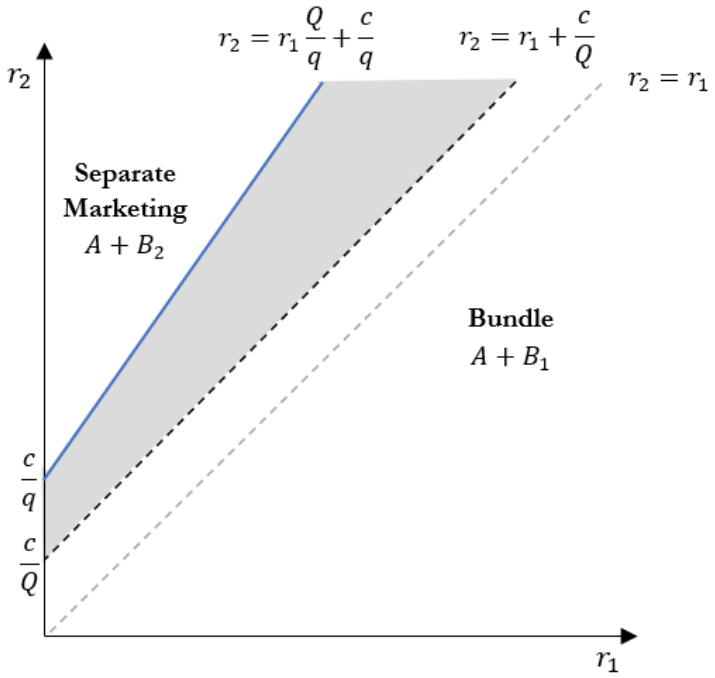
How $\boldsymbol{r_1}$ **and** $\boldsymbol{r_2}$ **impact the optimal decision of** $\boldsymbol{U_1}$ **to bundling?** Likewise to the timing modification model, when $r_1 \geq r_2$ bundling is the most profitable strategy for U_1 $(\hat{V}_1 > V_{1_{A+B_1}} > V_{1_A} > V_{1_{B_1}})$. Hence, it is important to know what is the best strategy for U_1 when $r_1 < r_2$.

When $r_1 < r_2$, U_1 chooses between its two most profitable options: bundling or selling only A. I only consider when $c \leq Q(r_2 - r_1)$ because otherwise, bundle is always

[45] $\hat{V}_1 - V_{1_{A+B_1}} = (\Pi - \pi - qr_2 + c + r_1 Q) - [\Pi - \pi + c - Q(r_2 - r_1)] = r_2(Q - q)$.

optimal, independently from $r_1 < r_2$.[46] Therefore, U_1 bundles when: $\hat{V}_1 \geq V_{1_A} \Leftrightarrow \Pi - \pi - qr_2 + r_1 Q + c \geq \Pi - \pi \Leftrightarrow r_1 Q - qr_2 + c \geq 0 \Leftrightarrow r_1 \frac{Q}{q} + \frac{c}{q} \leq r_2$

Figure 6 – Installed components and optimal bundling decision with compatibility costs



Equally to Scenario 4 of the previous model, the blue line from Figure 6 characterises the downstream firm's indifference between pre-installing the bundle or pre-installing only B_2. It also represents the limit of the optimality of U_1's bundling decision. Therefore, according to the proof and the graph, the most profitable strategy for U_1 is to bundle if $r_2 \leq \frac{Q}{q} r_1 + \frac{c}{q}$ and D pre-installs it. And when $r_2 > \frac{Q}{q} r_1 + \frac{c}{q}$ the optimal strategy for U_1 is to sell only component A and the downstream firm installs A and B_2 through separate marketing

The Figure 6 confirms that when U_1 bundles, it hampers the chances of B_2 pre-installation. In order to B_2 to be pre-installed, the U_2's direct revenue (or efficiency) greater than $r_1 Q$ is a necessary condition but no longer sufficient. The qr_2 must be also greater than the capacity cost incurred, $qr_2 > Qr_1 + c$. Thus, **bundling produces anticompetitive effects**, because in separate marketing U_2 only need to ensure that $Qr_2 > Qr_1 + c$. In other

[46] If $c > Q(r_2 - r_1)$ U_1 would decide between its two most profitable strategies: Bundling or selling A and B_1 in separate marketing and opts for the first as: $\hat{V}_1 \geq V_{1_{A+B_1}} \Leftrightarrow \Pi - \pi - qr_2 + r_1 Q + c \geq \Pi - \pi + c - Q(r_2 - r_1) \Leftrightarrow q \leq Q$.

words, when U_1 bundles, the efficiency of B_2 must be greater than the efficiency of B_1 by the proportion of the increase in sales that component A causes when installed (Q/q) plus the cost incurred.

The grey area of Figure 6 embodies the anticompetitive effect of bundling, which is caused by the increase of slope of D's indifference curve from $r_2 = r_1 + \frac{c}{Q}$ to $r_2 = r_1\frac{Q}{q} + \frac{c}{q}$. More specifically, in separate marketing D was indifferent between installing B_1 or B_2 if $r_2 = r_1 + \frac{c}{Q}$. However, when U_1 practices bundling, the component B_1 becomes more attractive to D, because installing B_2 implies not installing A. Therefore, when faced with the bundle option, the downstream firm only becomes indifferent between pre-installing B_1 or B_2 if $r_2 = r_1\frac{Q}{q} + \frac{c}{q}$.

Therefore, the anticompetitive effect (grey area) is quantified by $r_2(Q - q)$ which is the difference between the two D' indifference curves.[47] This value also represents U_1's profit increase and U_2's profit decrease due to bundling. Therefore, bundling presents the same anticompetitive effect $r_2(Q - q)$, independently from the compatibility costs, and U_1 continues to successfully leverage its dominance in market A to increase its profits in market B_i in the same way.

Although, when compared to Scenario 4 of the previous model, the area of optimality of bundling (or the conditions where D choose to pre-install the bundle) is greater in the presence of U_2's compatibility costs by $\frac{c}{Q}$ [48]. Meaning that U_2 has more difficulties to install B_2 in this model. Nevertheless, U_2 has the same increase of difficulty by $\frac{c}{Q}$ on Separate marketing (Scenario 3) in comparison to Scenario 3 of the original model. The value represents the shift of the D's indifference curve to the left by $\frac{c}{Q}$ caused by the compatibility costs, as shown in Figure 5. Thus, the bundle with synergies from this model does not have higher anticompetitive effects than the bundle without compatibility costs.

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[47] The difference between the two curves $(r_2 = r_1 + \frac{c}{Q} \Leftrightarrow Qr_1 = Qr_2 - c$ *and* $r_2 = \frac{Q}{q}r_1 + \frac{c}{q} \Leftrightarrow Qr_1 = qr_2 - c)$ is $(Qr_2 - c) - (qr_2 + c) = r_2(Q - q)$.

[48] The difference between the two blue curves of Scenario 4 between the two models $(r_2 = \frac{Q}{q}r_1 + \frac{c}{q} \Leftrightarrow r_1 = \frac{q}{Q}r_2 - \frac{c}{Q}$ and $r_2 = \frac{Q}{q}r_1 \Leftrightarrow r_1 = \frac{q}{Q}r_2)$ is $\frac{q}{Q}r_2 + \frac{c}{Q} - \frac{q}{Q}r_1 = \frac{c}{Q}$.

6. Discussion

6.1. The anticompetitive effect of bundling

As the results demonstrate, bundling harms competition and impede U_2 from competing on its merits, since its efficiency's superiority is no longer the deciding factor for component B_2 to be installed. This disadvantage caused by bunding is represented by the grey area on graphs from Figures 4 and 6. The effect of bundling on the competition is not a novel result. In fact, it is the most common one. Several notable authors like as Nalebuff (2004), Whinston (1990), Carlton and Waldman (2002) and J. P. Choi and Stefanadis (2001) reached the same conclusion. Although, on this dissertation, contrary to the previously cited articles, the objective of bundling is not to deter entrance nor it relies on two-period negotiations, but it has the same competition effects. The monopoly joint-control of two products give few opportunities for the rival firm to compete.

When compared to the original model, the profitability of bundling is higher when U_1 has synergies. This result is due to the increased U_2's difficulty to install B_2 when incurring in compatibility costs and since the downstream firm borne the cost through the reduction of upstream firms' slotting fees in the same amount. This result may indicate that cost advantages and synergies in the joint installation of the components may be an extra incentive for the monopolist firm to bundle, since it allows the company to practice a lower price for the bundle without decreasing its profits proportionally. This logic reasoning is comparable to when the monopolist firm bundles and has economies of scope (Kühn et al., 2005) or when rivals incur in entry costs (Carlton & Waldman, 2002).

However, the result that most intrigue us in the modified model with compatibility costs is that the bundle harms U_2 and D exactly by the same amount as in the original model. In a first instance, it would be expected that, since the U_2 firm incurs with compatibility costs, the bundling would not be as damaging or, perhaps detrimental, like when U_2 does not incur in costs. Because in the latter situation U_2 has higher profits and B_2 is exactly equal to B_1 in separate marketing. Hence, it would be expected that U_2 had more to lose when U_1 bundles in the original model.

Nevertheless, since the anticompetitive effects are exactly $r_2(Q-q)$ regardless of the synergy, the rationale of bundling for efficiency reasons may not be a valid argument to antitrust authorities for permitting the presence of pure bundling strategies (i.e. for

exempting Article 101(1)), because it infringes Article 101(3b) by detriment competition. This economic argument is also corroborated by Kühn et al. (2005). Indeed, pure bundling has anticompetitive effects and the synergies are not solely dependent on the bundling, as the results confirm when A and B_1 are sold separately the B_1 compatibility cost also extinguishes. Thus, besides the U_1's efficiencies, bundling may have an exclusion rationale with the objective of leveraging market power, similarly to J. Choi and Jeon (2018) and Whinston (1990) results. Furthermore, it infringes Article 101(3a) because the bundle is not strictly necessary to the execution of the objectives.

6.2. Bundling and investment in innovation

In separate marketing and without compatibility costs, U_2 only need to ensure that B_2's efficiency is superior to B_1 to be pre-installed. Nonetheless, when U_1 bundles, the previous condition is no longer sufficient. Therefore, when U_2 competes against the bundle, the firm has to invest even more in innovation in order to make B_2 even more efficient compared to B_1. Furthermore, if U_1 have synergies in selling both components, it is even harder for B_2 to be installed because its efficiency must also overcome the compatibility costs. Hence, likewise to J. P. Choi and Stefanadis (2001), bundling may discourage the decision of investment in innovation of B_1's rivals and, according to Etro and Caffarra (2017), for the monopolist firm either, since it does not need to produce a more efficient component than its rival in order to have it pre-installed.

6.3. Timing modification

In a first perspective, the feature of U_2 deciding its slotting fee second, after observing the slotting fee offered by U_1, it could be considered an advantage for U_2, since the firm will have more information to make its decision and thereby, offer its slotting fee at a value more suitable to win the competition for the installation of B_2. However, the results did not show any changes compared to the model with the original timing of Cornière and Taylor (2018). Meaning, that the timing of U_2 decision does not affect the outcome of the upstream and downstream firms in a bundling setup nor in separate marketing. The assumption of complete information, where firms know and anticipate rival's slotting fees and payoffs, allows firm U_2 to decide simultaneously with the same information as if it decided subsequently after U_1 with perfect information. Also, with complete information, when in

$t = 0$ U_1 announces its strategy, gives the necessary info for U_2's decision. Therefore, U_2 does not have any informational advantage by deciding after U_1.

6.4. Choice of the model

The wide-ranging literature on tying can be applied directly to analyse the Android case. I examined different models and related literature which could help explain the case and opted for the baseline model of homogenous consumers from Cornière and Taylor (2018). The model constitutes a decent representation of the vertical dimension of the smartphone applications market compared to other similar models.

Conferring to Whinston (1990) and Carlton and Waldman (2012), the authors do not approach the nature of the two-sided markets. This feature is important to include in the model, because the investigation concerns about the search engine and application store market, which are considered two-sided. Furthermore, their models do not include the possibility of the tying firm selling its tying product (Google Play) for free to final consumers. As the last differentiating factor, Whinston (1990) focus on entry deterrence rather than rival exclusion and does not consider negative prices. Although, Google gives financial incentives and slotting fees for its apps to be installed (RSA). Thus, it is necessary the inclusion of the possibility of negative prices in the model.

In the application store and search engine's markets, the price charged to final consumers is often null and suffers little or no variation. Then, it is improbable for a firm to increase the demand for the product by altering its price, as price externalities are rare. Thus, the increase of profit does not happen through vertical integration or joint-control which allows the firm to increase demand by reducing prices (Kühn et al., 2005). In the Cornière and Taylor (2018) model, the downstream firm's profit increase is achieved by lump-sum transfers from upstream firms to the downstream firm which produce no price externalities on the finished product.

Ide and Montero (2016) have a similar model to Cornière and Taylor (2018), but they assume that the upstream firms could sell its products directly to the final consumer, and this feature does not happen in the Google Android case. Although, Ide and Montero (2016) have a different key aspect for the explanation of the extension of the monopoly's market power to an adjacent market through bundling, the high level of downstream competition and the heterogeneity of the population. The importance of downstream competition would

also approximate the model to the reality of the case. Cornière and Taylor (2018) also suggested this aspect for further investigation, but since Ide and Montero (2016) already cover that feature I decided to introduce compatibility costs.

The recent article of J. Choi and Jeon (2018), also motivated by the Google-Android antitrust case, provides an innovative way to examine tying in two-sided markets. The authors highlighted the importance of non-negative price constraints on the profitability of tying and leveraging market power. The Cornière and Taylor (2018) model differentiates from J. Choi and Jeon (2018) because of the inexistence of the non-negative price constraint. Although in both papers, bundling relaxes competition. In Cornière and Taylor (2018) it happens because of the decrease of U_2's willingness to pay slotting fees, as a result of the assumption of retail complementarity. In J. Choi and Jeon (2018) the competition is relaxed due to the non-negative price constraint - The monopoly's rival cannot practice negative prices. Thus, it cannot compete with the tied product which is being sold at a zero or a negative price.

6.5. Slotting fees

In Bertrand competition, price competition is so intense that two firms achieve the perfectly competitive outcome. In this model, since one firm has some form of cost advantage in selling its component, we move to an asymmetric Bertrand competition (Boone, Larraín Aylwin, Müller, & Ray Chaudhuri, 2012). The slotting fee appears as a result of fierce price competition. The upstream firms offer lower prices subsequently until the price becomes negative, because there are no marginal costs. Then, firms can recoup the negative price on the consumer side of the market (their direct in-app revenue). Consequently, the negotiations end when the least efficient firm offers its best price and has null profits.

In this model, the provision of free components aims to extend the dominance of the tying component to the tied component market. On two-sided platforms like Google's applications (consumers and advertisers), this is a common practice: a platform operator provides a service to users without directly charge it, and chooses to profit from fees charged by third parties (R. H. Bork & Sidak, 2012; Geradin & Edelman, 2016). Those third parties are application developers and advertisers. The revenues from advertising plus a fixed percentage of app developers' revenues are represented in the model by r_1.

Similarly to the model of Etro and Caffarra (2017), the offering of slotting fees to the downstream firm for the bundle to be installed, provides a rationale for the financial

incentives that are currently attributed by Google to OEMs for exclusivity, the RSAs. However, this dissertation interprets the slotting fees not for exclusivity reasons, because exclusion is already achieved through the MADAs, that is, through the contractual bundling.

7. Conclusions

The present dissertation contributes to the analysis of the consequences of bundling on the vertical chain competition segment in a scenario in which compatibility costs and synergies are present. Furthermore, it is provided a brief overview of the European Competition Law in order to understand the infringements and the legal framework of Google's tying practices. In addition, this study may provide additional information to the antitrust policy, on a theoretical perspective, on how the anticompetitive effects are altered according to the cost structure of the companies.

The model with compatibility costs incorporate the specificities of the alleged efficiencies that Google claims to have when its applications are installed together and demonstrates the incompatibilities that their rivals face when their apps are pre-installed instead of the Google Mobile Services applications. At a first impression, this bundling justification for efficiency reasons appears to produce less anticompetitive effects than in the absence of synergies, since rivals already have a component that is less desirable for the downstream firm (lower slotting fees) in separate marketing, so bundling would not "steal" a substantial rival's profit.

Nevertheless, our results show that bundling displays equal anticompetitive effects, regardless of the synergies or compatibility costs. Therefore, this efficiency justification of bundling does not seem to be a strong argument in favour of competition authorities for permitting this practice, since the anticompetitive effects are the same. The model reveals that bundling has the sole purpose of capturing the global value of component A and its synergies only make bundling even more profitable, because the compatibility costs makes even more difficult for rivals to pre-install its components. This increased rival's difficulty prevents it from competing on its merits and may demand an extra investment in innovation to create a superior component. Therefore, bundling may diminish incentives in innovating because the monopolist does not need to have a more efficient component in order to be pre-installed.

This dissertation also demonstrate that bundling allows profitable leveraging of market power and shows how the downstream firm is harmed by bundling. That is, when the monopolist bundles, it decreases rival's willingness to pay slotting fees. As consequence, the downstream firm's profit is smaller compared to its profit in separate marketing.

7.1. Further research suggestions

Since the European antitrust policy focus more on the consumer's welfare than anticompetitive effects (Tirole, 2005), the model with compatibility costs presents some limitations on the assessment of how consumers are affected by this synergy. It is important to assess, for example, if consumers are better served with the free pre-installed bundle, or with a free choice of pre-installed apps, but with the possibility of being charged for having the Android OS. And, taking into account consumer's preferences and utility for the applications pre-installed.

In EU Competition Law standpoint, more specifically, accordingly to the Article 101(3) TFEU, even if consumers are better served with the bundle and the latter produce efficiencies, the bundle should not be allowed if it eliminates a substantial part of the competition (Article 101(3b)) and if imposes restrictions that are dispensable for the objectives (Article 101(3a)). In Google's appeal, the firm claims to have credible rivals in the operating system market and the bundle is necessary to offer the Android OS for free. Therefore, even if Google's allegations do not represent the reality, the assessment of how consumers are affected by this bundling reveals to be an important issue to explore. For instance, is mandatory unbundling an optimal antitrust policy if implies superior prices and a possible reduction of technological progress, leaving consumers worse-off? In summary, investigating these previous questions would be important to the literature of tying and European Competition policy. This research avenue may provide additional insights of the effects of bundling and mandatory unbundling on the consumer side of the market of the Google-Android case. And, it may clarify and redefine this competition policy trade-off between consumer's welfare and technological progress with the objective of ensuring competition from Article 101(3b).

The timing modification produced the same results of Cornière and Taylor (2018). Although, additional interpretations for the results were provided. Like the analysis of how component's efficiency alters the optimal decision of bundling. The assumption of complete information permits rivals to decide simultaneously with the same information as if they decided after the monopolist with perfect information. Therefore, as another possible expansion of this dissertation could be considering incomplete information in the negotiation process. It may be interesting to study how this modification could affect downstream firm's revenue, and whether bundling would continue to be optimal for the

monopolist since the latter would not know the downstream firm's preference between installing the bundle or the rival component.

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